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FOURTH ANNUAL REPORT

OF THE

STATE DEPARTMENT OF HEALTH

OF

MASSACHUSETTS

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approved by the
Supervisor of Administration.

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FOURTH ANNUAL REPORT

OF THE

STATE DEPARTMENT OF HEALTH

OF

MASSACHUSETTS.

For the fiscal year ending Nov. 30, 1918, the State Department of Health was constituted as follows: —

Commissioner of Health (until April), . . ALLAN J. MCLAUGHLIN, M.D.
Commissioner of Health (appointed April 1), . EUGENE R. KELLEY, M.D.

PUBLIC HEALTH COUNCIL.

EUGENE R. KELLEY, M.D., *Chairman.*

DAVID L. EDSALL, M.D., 1921.
J. E. LAMOUREUX, M.D., 1921.
WM. J. GALLIVAN, M.D., 1919.
JOHN T. WHEELWRIGHT, 1919.
GEORGE C. WHIPPLE, S.B., 1920.
WM. T. SEDGWICK, Ph.D., 1920.

During the year fifteen formal meetings of the Council were held, and in addition numerous meetings of the standing and special committees of the Department. The standing committees are as follows: —

SANITARY ENGINEERING (INCLUDING HOUSING AND RURAL HYGIENE).

Professors Whipple and Sedgwick, Dr. Kelley and Mr. Wheelwright.

PREVENTIVE MEDICINE AND HYGIENE.

Drs. Edsall, Gallivan, Kelley and Lamoureux.

FOOD AND DRUGS.

Professor Sedgwick, Drs. Gallivan and Lamoureux.

FINANCE, LAW AND DEMOGRAPHY.

Dr. Kelley, Professor Whipple, Dr. Gallivan and Mr. Wheelwright.

On April 1, 1918, the Department suffered a heavy loss in the resignation of the Commissioner of Health, Dr. Allan J. McLaughlin.

By an act of the Legislature of 1914 the State Board of Health, which had existed since 1886, was replaced by a Department of Health composed of a Commissioner of Health and a Public Health Council, and in the autumn of that year Dr. McLaughlin was appointed to the commissionership. To this new and important post Dr. McLaughlin brought a high reputation as an officer of the United States Public Health Service, with unusual experience in public health activities, both scientific and administrative, in the United States, in Europe and in the Philippine Islands. For three years and a half he devoted himself unsparingly to the service of the State of Massachusetts, bringing the new Department of Health to a high level of usefulness and success, and demonstrating by his professional knowledge, his ability, his energy and his personality, administrative qualities which won for him the regard and respect of his associates and subordinates.

The vacancy left by the resignation of Dr. McLaughlin was immediately filled by the appointment of Dr. Eugene R. Kelley, Director of the Division of Communicable Diseases of the Department, and formerly Health Commissioner of the State of Washington.

Rufus Mason Whittet, C.E., principal assistant engineer of this Department, died on Dec. 10, 1918, a victim of the prevailing influenza epidemic. Mr. Whittet joined the engineering staff of the State Board of Health upon his graduation from the Massachusetts Institute of Technology in 1902, and had been the principal assistant engineer of the Department since 1908. His energy, thoroughness, clear thinking and sound judgment were of invaluable assistance in the studies of water supply and drainage, and the great variety of kindred problems embraced in the work of the Department, while his quiet manner, his fairness and his kindness made work with him a pleasure. These qualities, with a high sense of honor and loyalty to his associates, made him respected by all and loved by a wide circle of friends.

In accordance with section 2, chapter 792 of the Acts of 1914, at a meeting of the Public Health Council on Dec. 24, 1918, the Commissioner of Health submitted to the Council a report of the activities of the Department for the fiscal year 1917, together with recommendations for legislation, and it was voted that this report be approved and adopted as the report of the State Department of Health for the fiscal year 1918.

REPORT OF THE COMMISSIONER OF HEALTH.

To the Public Health Council.

GENTLEMEN: — In the fiscal year 1918 events have occurred and circumstances arisen of such unusual character as to render the year noteworthy in the health annals of the Commonwealth. In the list of unusual occurrences the great influenza epidemic with its unprecedented mortality holds first place. This disaster is still too recent to permit exact statements, and its remote effects upon the public health cannot as yet be predicted. It has largely overshadowed certain other important health developments of the year that deserve emphasis, as the effect of war conditions upon the work and personnel of the Department, especially the Department's venereal disease campaign, and the progress of the child conservation measures inaugurated during the previous year. Before summarizing the routine and emergency activities of the several divisions of the Department, I desire to comment upon each of these subjects.

THE INFLUENZA EPIDEMIC.

Massachusetts is just emerging from the most disastrous epidemic that the Commonwealth has ever known. While the statistical data of sickness and death caused by it are not as yet available so that exact comparisons can be made, the incomplete records indicate that the initial point of invasion into the country was among naval units stationed within the State; that the virulence of the disease was relatively high within our borders; that Boston and certain of the larger cities of the Commonwealth were stricken with unusual severity; and that possibly the State as a whole suffered greater proportional infection and fatality than any other in the Union.

Deaths from the resultant pneumonia are still occurring daily in many parts of the State, and it is too early to obtain complete returns for the month of November. From returns available it is very evident that the total mortality, exclusive of deaths among military forces within the State, directly attributable to the epidemic is probably not less than 15,000 from its inception in the second week of September to the 1st of December.

The total number of cases cannot be determined with any such degree of accuracy as can the deaths. Conservatively estimated, at least 400,000 persons were affected over the same period to the extent of being unable to pursue their ordinary occupations for several days. Moreover, strictly speaking, the epidemic cannot be said to be over, as many cases are still being reported from various localities.

Influenza had never been one of the reportable diseases in Massachusetts. At the beginning of the epidemic the local boards of health were requested by the State Department of Health to report all cases and deaths due to influenza. Later, by vote of the Public Health Council on September 30, influenza was added to the list of reportable diseases. By this means prompt warning of new foci of infection was given, and more accurate knowledge of the increase or decrease of the number of cases in a given community was furnished. Acting upon this information the Department was better enabled to furnish medical and nursing assistance to the localities most in need, and to send pamphlets giving instructions relative to the care of the sick to the homes from which cases of the disease were reported.

The task of combating influenza was greatly hampered by the inadequate supply of physicians and nurses, due in great part to military enlistment. A medical and nursing enrollment bureau was established at the State House by the Department, and calls were sent throughout the New England States, New York and Pennsylvania for physicians, graduate nurses and nursing assistants. An appeal was sent to the Federal government for physicians and nurses. Advertisements were placed in the newspapers calling for aid, and local boards of health were requested to send in a statement of their existing nursing and medical resources and hospital accommodations, as well as their need for further assistance. On September 30 Passed Assistant Surgeon W. S. Draper, detailed from the United States Public Health Service, with seven commissioned officers as assistants, reported for duty. Dr. Draper's office was established in the State House, and his assistants were detailed to the larger cities. The assistance furnished by the Federal government in this manner was exceedingly valuable, and was deeply appreciated throughout the State.

An epidemic emergency committee headed by Mr. Henry B. Endicott, executive manager of the State Public Safety Committee, was appointed by the Governor, and co-operated with the Department most vigorously throughout the epidemic. Under the leadership of this committee volunteer organizations sprang up throughout the cities and towns of the State, which busily engaged in questions of supplies, relief, emergency hospital equipment, enrolling of volunteer assistance, and numerous other activities designed to assist the city and town boards of health, hospitals and other official groups dealing with the epidemic. The existing hospital facilities of the State were entirely inadequate to accommodate the vast number of cases requiring hospital care, and about 50 emergency hospitals, varying in size from 5 to 500 bed capacity, were established.

In those communities where the hospital situation was most serious,

upon request of the local civic authorities and recommendation of this Department, the State Adjutant-General, Quartermaster-General, and Surgeon-General established tent and shack military hospitals. Very excellent results were obtained in these hospitals, all of which were conducted upon the open-air principle. In all, 9 such military hospitals were established, with a total of 2,020 patients admitted and an average fatality per cent of 14. They were located in the following communities: Brookline, Gloucester, Brockton, Ipswich, Lawrence, Waltham, Haverhill, Barre and Springfield. Special recognition should be made of the self-sacrificing spirit in which so many co-operated throughout the State to make these institutions a success.

The Governor was requested to communicate with army and navy authorities, and to recommend that all leaves of absence for soldiers, sailors and other personnel under their control be discontinued during the course of the epidemic.

Dr. Timothy Leary, professor of pathology at Tufts Medical College, produced an influenza vaccine which it was hoped might prove an effective prophylactic and therapeutic agent. The following special boards were appointed for the scientific and statistical investigation of the efficacy of this vaccine: special board for statistical investigation, George C. Whipple, chairman, William H. Davis and F. S. Crum; special board for scientific investigation, M. J. Rosenau, M.D., chairman, Dr. Frederick P. Gay and Dr. George W. McCoy. It was felt that there should be no delay in providing the public with an agent having promise of good. Accordingly, Dr. Leary was authorized to proceed with the manufacture of this vaccine in quantity at the expense of the Commonwealth before the reports of the boards were received, in order that a favorable report might find the Department with a supply on hand for immediate distribution. This was done at a total expenditure on the part of the Commonwealth of over $19,000. The report of the special reference board was not entirely favorable, and reports from physicians making use of the vaccine were contradictory. A considerable supply was, however, distributed, meeting all calls for it, because it was felt that any measures sponsored by a pathologist of Dr. Leary's professional reputation should be given the fullest trial. Detailed reports as to its preventive effects were requested from the persons to whom vaccine was administered, as well as from physicians and institutions. Although in some instances striking protective results were reported, these were offset by other instances where no protection was observed. Carefully checked results were followed in the case of a large State institution, where a total of 403 persons from both the administrative staff and the institutional inmates, well distributed in various parts of the institution, representing 40 per cent of the total population, were vaccinated and the

remainder not vaccinated. The disease had not occurred in the institution prior to the vaccination, but did appear soon thereafter, the first case occurring four days after the completion of vaccination. Of those vaccinated, 40 per cent were taken sick, and of those taken sick in this group 17 per cent died. Of those unvaccinated 31 per cent were taken sick, and of these 13.5 per cent died. From this and similar occurrences the staff of the Department regretfully but unanimously was forced to the conclusion that upon the evidence available the vaccine had no marked prophylactic value.

In all, during the course of the epidemic, 1,003 nurses and nurses' aids registered and were sent out by the enrollment bureau for service in different parts of the State. Of these nurses and nurses' aids 79 contracted the disease while in the State's employ, and 7 of the cases were fatal. Of the 15 nurses sent by the Commonwealth of Pennsylvania to aid Massachusetts in the early stages of the epidemic, 2 died of the disease after their return home. Two hundred and fifty physicians and fourth-year medical students were sent out by the enrollment bureau, and of these, 113 accepted commissions in the Federal Public Health Service. Many of these physicians, nurses and assistants came from a distance to aid Massachusetts, and all gave unstintingly of their strength and time in helping to check the inroads of the epidemic. To each and all of them the Commonwealth is deeply grateful.

In addition to the expenditures by the Adjutant-General's office and the State Public Safety Committee, the total financial liability assumed by the Commonwealth through this Department, with the approval of the emergency health committee, in combating the influenza epidemic amounts approximately to $100,000. The principal items of expense are for salaries and expenses of physicians, nurses and nurses' aids, — approximately $75,000, — and for the expenses incidental to the manufacture and testing of influenza vaccine, — approximately $19,000.

The Influence of the War upon State Health Activities.

The direct and remote effects of the war upon the activities and personnel of the Department during the past year have been far-reaching,

The most prominent change was the recalling of the Commissioner. Dr. Allan J. McLaughlin, on April 1, 1918, to active duty as Assistant Surgeon-General of the United States Public Health Service.

In addition to losing the aggressive leadership of Dr. McLaughlin as a result of the war, the Department has sustained throughout the year constant losses in its personnel, until in all 33 out of a total force of approximately 125 have entered active military service.

Service Roll of Department.

A. J. McLaughlin, M.D.,	U. S. Public Health Service.
Mary Dopkeen,	U. S. Naval Service.
Joseph P. Baggs,	7th Field Artillery, U. S. A.
Forrest E. Harbour,	115th Regiment, Engineers, U. S. A., A. E. F.
Francis F. Kingsbury,	306th Regiment, Engineers, U. S. A., A. E. F.
Arthur D. Weston,	Engineers' Reserve Corps, U. S. A., A. E. F.
Alexander Bresth,	Sanitary Corps, U. S. A.
E. R. Hatton,	U. S. Naval Service.
John J. County, Jr.,	101st Regiment, Engineers, U. S. A., A. E. F.
William L. Campion,	Red Cross Service.
Joseph F. Coughlin,	469th Cons. Squadron, Air Service, U. S. A., A. E. F.
Alexander W. Beckett,	101st Regiment, Engineers, U. S. A., A. E. F.
William W. Walcott, M.D.,[1]	101st Regiment, Engineers, U. S. A., A. E. F.
John A. Doherty,[2]	Infantry, U. S. A., A. E. F.
James S. Kingston,	101st Regiment, U. S. A., A. E. F.
Samuel L. Ellsworth,	26th Regiment, Engineers, U. S. A., A. E. F.
Oscar R. Peterson,	601st Regiment, Engineers, U. S. A., A. E. F.
Joseph A. McCarthy,	302d Regiment, U. S. A.
Joel I. Connolly,	U. S. Public Health Service.
Allen M. Symonds,	U. S. Naval Service.
William A. Clark,	303d Regiment, Engineers, U. S. A.
Stanley H. Osborn, M.D.,	Medical Officers' Reserve Corps, U. S. A. A. E. F.
Josephine M. Washburn,	U. S. Naval Service.
Ernest R. Bower,	Hospital Corps, U. S. A.
Katherine Marden,	Sanitary Bacteriologist, U. S. Public Health Service.
Howard D. Williams,	Medical Corps, U. S. A.
J. Chester Cressey,	U. S. Naval Service.
John Crawford,	24th Regiment, Infantry, U. S. A.
Edward Wright,	Sanitary Corps, U. S. A.
Walter D. Lowell,	U. S. Naval Service.
Warren J. Scott,	U. S. Naval Service.
Francis Howden,	Sanitary Corps, U. S. A.
Walter E. Merrill,	Sanitary Corps, U. S. A.
George L. Drury,	Veterinary Corps, U. S. A.

In addition to the loss of personnel due to those actively entering service, the extreme measures adopted by the medical section of the Council of National Defense to stimulate medical reeruiting induced in the medical personnel of the Department, in common with other health departments throughout the country, a condition of mental un-

[1] Died in France March 16, 1919, from disease contracted in line of duty. [2] Killed in action.

rest and uncertainty as to whether or not it was their duty to drop their civilian obligations and enter military service, which greatly interfered with the morale of the entire Department.

The medical department of the army, after numerous conferences with representatives of the State health authorities of the country, recognized the military necessity of maintaining civilian health departments by declining to commission officers of State health departments without certification from the head of the Department that their entering upon military service would not handicap the work of the health department. On this ground, upon reference by the Surgeon-General's office, the issuance of commissions to several medical officers of this Department was deferred for several months. Following the subsidence of the influenza epidemic, several district health officers were about to enter active military service when the cessation of hostilities stopped all inductions into military service.

Aside from the direct effect upon the Department of so many of its personnel entering the military service or awaiting release for entering into such service, the war has in many other ways handicapped the normal progress of health activities throughout the Commonwealth. Practically all new hospital construction has been stopped by action of the Federal authorities. The insistent call for nurses for military service has seriously curtailed public health nursing throughout the State, and stopped nearly all extensions of such service among the cities and towns of the State. The large number of physicians in the Commonwealth from the staffs of tuberculosis institutions and clinics, prenatal and postnatal clinics, and of school physicians, etc., entering military service has seriously handicapped health activities during the past year.

The Development of the Venereal Disease Campaign.

Although in certain respects, notably in establishing venereal disease clinics, the shortage of trained physicians due to military enlistment has handicapped progress in venereal disease treatment, on the whole the state of war has wonderfully stimulated the progress of the venereal disease campaign, particularly in lines of education and prevention.

The most encouraging development has been the close interlinking of the venereal disease activities of the War Department, the United States Public Health Service, and the Commission on Training Camp Activities with those of the State health departments of Massachusetts and the other New England States.

The coming of peace cut short many lines of venereal disease educational work among draftees and student army training corps units

which had been planned to be carried out by co-operation between military and civilian health authorities under the able leadership of Maj. Alec N. Thomson, M. C., U. S. A.

By special detail Major Thomson acted as director of the Department's Subdivision of Venereal Diseases for a period of several months, in addition to supervising the venereal disease prevention work for the Northeastern Department of the army.

The venereal educational film of the War Department, "Fit to Fight," has been exhibited in most of the large cities of the State by the Department. Large and appreciative audiences have witnessed this film, and the educational benefits of the lessons of the dangers of venereal disease imparted thereby are believed to be of great value.

The response of the medical profession to the system of reporting venereal diseases has been very encouraging. Illustrative of the practical preventive value of the venereal disease campaign is the large number of patients of both sexes whose names have been reported to the Department by physicians, under the regulations, because of lapsing treatment while still in an infective stage, who have been "followed up" by the Department and placed under regular treatment up to the point of cure or non-infectivity.

During the year the manufacture of arsphenamine has advanced from the experimental to the factory stage, and is now rapidly approaching a regular quantity production sufficient to fill all the needs of the State.

All phases of State venereal disease work have received great stimulation from the passage of the Kahn-Chamberlain law, which divides $1,000,000 annually among the States for anti-venereal disease work under regulations laid down by the Federal Public Health Service, and conditional upon each State appropriating an equal amount. Under the provisions of this law Massachusetts receives $36,000 annually for venereal disease work.

Child Hygiene and Prevention of Infant Mortality.

No part of public health activities deserves more careful study by the health administrator than child hygiene. No phase of public health work, intelligently and intensively cultivated, yields more immediate and permanent returns. Nothing connected with preventive medicine contributes eventually so greatly to the economic and social growth and prosperity of a Nation or State as effective work in child conservation.

The best national life insurance a country can carry is to have its population on the increase rather than at a standstill or declining.

The events of the past four years have shown the vital importance of "man power" conservation in such fashion that no elaboration of argument is needed to demonstrate its importance to national efficiency and prosperity.

Reduced to its simplest terms, the importance of infant and child hygiene may be stated as follows: —

1. One of the most fundamental, if not the most important of all, factors in assuring continued national existence and prosperity is a healthy development and increase of human resources.

2. Only three factors can be reckoned upon to produce this result: —

(*a*) Immigration.

(*b*) A high birth rate.

(*c*) The reduction of mortality in the juvenile and young adult age groups.

Examining these three factors and applying them to the United States, we reach certain conclusions: —

1. Immigration of young adults, with a high birth rate among recent immigrants, has been the great source of our expanding population throughout our history, and in an increasing degree in the past fifty years.

2. The indications are that this factor will decrease in the future.

3. In common with practically all Caucasian nations the native birth rate of *recent immigrant* parental stock, as well as of "American" parental stock, is constantly declining; hence we can rely less and less confidently upon native births providing such a large surplus reservoir of population that the nation in the future can afford to be as careless of the conservation of its human assets as it has been in the past.

4. If the validity of the three previous conclusions is granted, we cannot escape the conclusion that now as never before does the conservation of human life, at least in the productive periods, become a matter of deep and vital national concern.

5. Surveying the entire field of life conservation in its relation to the future population, two things at once become evident: —

(*a*) That nowhere is the national loss in actual or potential population so great as in the age group under five years.

(*b*) That in no other age group can so much of this waste of vital assets be stopped so quickly, efficiently and cheaply by tried and efficient measures as in this same age group.

In this new era of our national life the conservation of child life becomes a matter of vital concern to every citizen, and the saving of thousands of children's lives, now lost annually in this country through ignorance and economic handicaps, can be made by proper precautions.

New Zealand is a small country, and in common with some other countries it has for decades faced the problem of a steadily declining native birth rate. As a nation it has attacked seriously the problem of salvaging its infant and child assets to a degree that no other country has even remotely approximated, and has cut its infant death loss in half in the past fifteen years.

For the past year and a half this Department, through its child conservation committee, has consistently, although with meager personnel and funds in comparison with the size of the problem, endeavored to induce the cities and towns of the Commonwealth to inaugurate the same simple methods for infant and child life saving that have proved so effective in many other parts of the world as well as in New Zealand. The need for these measures is doubly great just at present, for the direct and indirect effects of war conditions tend to lessen the natural increase by birth and to increase the fatality of infants' and children's diseases. The results of the campaign are greatly encouraging as to immediate accomplishment, and full of promise as to the future.

In general it may be said that the greatest instrument in our hands for child conservation is instruction, — personal contact rather than long-range instruction; lessons by demonstration rather than by precept or pamphlet; teaching the potential and prospective, as well as the actual and perplexed, mother as to the "what and why" of infant and child hygiene, given her in her own home or at convenient near-by centers in company with neighboring mothers, given her on a plane of equality and friendship by one who has her welfare at heart. This type of information in "mother craft" saves lives, and this type of practical hygiene can best be imparted by the trained child-welfare or public health nurse.

In the last annual report of the Commissioner the organization of the Department's child conservation committee and the plan adopted for this work were explained in some detail. During the year the plans for surveying all communities have been carried out with a high percentage of completeness and with very encouraging results from the standpoint of the increased interest in child welfare work exhibited by various cities and towns, the amount of money appropriated both by city and town governments and by private organizations, and in the number of new nurses placed in the child welfare field. It is felt that the work so well begun by the child welfare committee has now demonstrated its usefulness to such a degree that, while such intensive surveys will not be necessary in the future, the State Department of Health should maintain competent experts in child welfare work to correlate and supervise activities in these fields throughout the State.

Detailed reports upon this work have already been published in the monthly bulletin of the Department in a special double issue (September–October), and a review of it is given in the report of the Division of Hygiene.

Legislation recommended.

1. A resolve relative to an investigation by the State Department of Health and the Metropolitan Water and Sewerage Board, acting jointly, of the water-supply needs of the inhabitants of the Commonwealth.
2. A resolve authorizing the State Department of Health to investigate and to carry on preventive work against cancer.
3. An act relative to the cold storage of articles of food.
4. An act relative to the duties of members of boards of health acting as inspectors of slaughtering.
5. An act relative to the slaughtering of neat cattle, sheep and swine.
6. An act providing for the appointment of a deputy commissioner of health.
7. A resolve providing for an investigation of the medical inspection of schools of the State by the State Department of Health, the State Board of Education and the State Commission on Mental Diseases.

Activities of the Divisions of the Department.

Division of Administration.

The work of the Division of Administration has continued on similar lines to that of previous years. In the Massachusetts State Department of Health the Division of Administration does not in any sense act as a general supervising organization for the other divisions of the Department, but consists of two subdivisions where the accounts and records of the Department are kept. The steady growth of the work of the Department has thrown heavy additional work upon those in charge of the accounts and files, which has been carried on without additional assistance. The emergency requirements due to the influenza epidemic were very heavy and involved a great deal of overtime work from all the employees of the Division, as well as from the Divisions of Communicable Diseases and Hygiene.

I wish to take this opportunity to express my appreciation of the splendid spirit in which all the employees of the different Divisions of the Department gave so unsparingly of their time and strength throughout the continuance of the epidemic.

Division of Sanitary Engineering.

X. H. GOODNOUGH, C.E., DIRECTOR.

The applications received for advice as to water supply, sewerage, etc., during the past year have numbered approximately the same as in the previous year, but there has been a considerable difference in the general character of the work. Very little work has been undertaken by cities and towns in the introduction or extension of water supplies and sewerage systems, except in cases of emergency, but an unusual number of applications for advice as to water supply and sanitation of military and other camps have been presented for the advice or approval of the Department.

The winter of 1917–18 was far more severe than any experienced in Massachusetts since the general introduction of water supplies was begun, and a great many service pipes and even supply mains became frozen. After the first severe cold in December, 1917, faucets were quite generally allowed to run continuously. Under these conditions reservoirs became depleted, and there were serious shortages of water in many places. Water consumption in the spring months was much greater than in the same months of the previous year, due largely to leakage caused by the freezing of pipes. It has not been practicable in many places to make the repairs and improvements required to reduce the consumption to the normal amount.

At Lawrence the distributing reservoir, holding about 40,000,000 gallons, became nearly exhausted toward the end of the winter, notwithstanding that the filters were operated to their greatest capacity and all the water practicable was obtained from the adjacent towns of Andover and North Andover. On account of this situation the Department called a conference on October 23 with the authorities of the city and advised them that the covering of an additional portion of their filters was essential in order to make provision for an adequate water supply during the coming winter. The city water commissioner carried through the covering of the filter promptly and efficiently in season to put the filter in operation at increased capacity before the beginning of cold weather. The Department has recommended to the city government that it make still further provision for the enlargement of its filtration works in 1919, so as to provide an ample supply of filtered water for the city's immediate needs and discontinue the purchase of water from Andover and North Andover.

An important decision relating to the question of fishing in public water supplies was given by the Supreme Court on February 9 in the case of Commonwealth *v.* Hyde, involving the power of the State

Department of Health to regulate or absolutely prohibit fishing in waters used as sources of water supply under the provisions of section 113, chapter 75 of the Revised Laws. The court in this case found that the regulation of fishing, and even its absolute prohibition, could not be deemed unreasonable in the circumstances.

Because of the financial, material and labor restrictions imposed by war conditions little or no progress has been made in the works for the treatment of sewage and manufacturing waste for the relief of the polluted streams of the State, although a number of existing works for sewage disposal urgently require extension or improvement.

The quantity of manufacturing waste produced at many of the mills has increased very greatly during the year, but, by reason of the difficulty of obtaining labor and materials, very little has been done toward the treatment of such wastes.

In addition to the regular work of the Division, several special requirements which were imposed upon the Department by the Legislature of 1918 have been included in the duties of this Division. These were: —

1. Improvement of Hale's, or River Meadow, Brook in Lowell. (Chapter 92, Resolves of 1917, and chapter 24, Resolves of 1918.)
2. The use of the summer flow of the Ipswich River for the water supply of Salem and Beverly. (Chapter 73, Resolves of 1917, and Chapter 26, Resolves of 1918.)
3. A plan for a system of sewerage and sewage disposal for the town of Ayer. (Chapter 58, Resolves of 1918.)
4. Investigation of the cost of a sewerage system to prevent the pollution of the Mystic Lakes. (Chapter 34, Resolves of 1918.)

The necessary surveys and investigations relative to the improvement of Hale's Brook and for the design of a sewerage system for the town of Ayer were completed near the end of the year, and work has been begun upon the question of the use of water from the Ipswich River; but with the very limited engineering force available to the Department it has not been practicable to complete this work or begin as yet the investigations relative to a sewerage system for the protection of Mystic Lakes.

Under chapter 182 of the General Acts of 1918 surveys and studies relating to the determination of the ownership and area of lands benefited by the improvement of the Neponset River have been continued and are likely to be completed soon after the end of the year.

The law enacted by the Legislature of 1918 for the protection of the public health in the vicinity of Alewife Brook in the towns of Arlington and Belmont, and in the cities of Cambridge and Somerville (chapter

88, General Acts of 1918), relates to the protection of a tributary of the Mystic River draining a considerable area in the municipalities named, including a large area of former salt marsh made available for reclamation by the dam at Cradock Bridge. The investigations to determine the sources of pollution of this stream had not been completed at the end of the year because of inability to secure the necessary engineers to do the work.

Under the provisions of chapter 289 of the General Acts of 1918, relative to the improvement of certain low lands, the Drainage Board created by that act has been organized, and work upon the investigations therein authorized has been begun. The act is an important one and is in line with the legislation already adopted in many other States designed for the development and utilization of wet lands for agricultural or other purposes, or for their drainage for the protection of the public health in case such work shall be found necessary or useful. The act provides in general that proprietors of low lands desiring to improve them for any purpose may secure the advice of the Drainage Board as to the advisability and cost of the proposed improvement without expense to themselves; and if the improvement proves likely to be sufficient to warrant the cost, the work is to be carried out by the county commissioners and assessed upon the lands benefited through the cities and towns in which they are situated.

Division of Water and Sewage Laboratories.

H. W. Clark, Director.

During the year 1918 the usual chemical, bacterial and microscopical examinations of samples from the water supplies, rivers, etc., of the State were made, this work necessitating the making of 4,206 chemical, 1,450 microscopical and 1,750 bacterial analyses. Studies of sewage areas, the purification of sewage, trade wastes, purification of water, examinations of shellfish, etc., called for 2,396 additional chemical and 2,286 bacterial examinations.

Special work was done in connection with the purification of the water supplies of Lawrence, Beverly and Salem.

Studies were made of the use of chloramine in connection with bleach for the purification of water.

Tests were made in regard to the treatment of water with a new pattern of ultra violet ray lamp.

Investigations were made of the disposal and purification of manufacturing wastes from many industrial works, and special studies were made in regard to several of them upon which reports were made to the Department.

Continuous studies were made during the year of the Miles acid process for the treatment of sewage; of various forms of activated sludge tank work; of the method of flow of liquids through activated sludge or sedimentation tanks, together with studies of the control of such flow by baffles, etc.; and quite extensive studies were made in regard to the comparative amount of recoverable material of value resulting from the treatment of sewage by the Miles acid process, activated sludge tanks and trickling filters.

During the year further work was done in regard to the removal of color from water, and special bacterial studies were made of certain ground waters in the State.

On account of the war it has been hard to obtain competent assistants and to keep them when obtained. Several men left our employ during this year to enter the government service or to accept more highly paid positions in industrial works.

Division of Communicable Diseases.

J. S. Hitchcock, M.D., Director.

During this year the State has had a remarkably small number of outbreaks of disease in epidemic proportions.

We believe, although arguing by exclusion only, that the system of using our endemic index as an alarm clock has had this effect. In negative corroboration of this, the facts in regard to measles are of interest. Because of the very early infectivity of this disease its spread is largely in advance of information obtainable from the use of the endemic index, and theoretically we should get no results therefrom. Apparently we get none. Epidemics of measles have appeared in the usual number and size. Influenza also leaps all our barriers in a manner quite like measles. May not this indicate that its communicability is, like measles, most active in very early, practically presymptomatic, stages?

There were only 90 instances where outbreak notices were sent to District Health Officers, divided as follows: —

Diphtheria,	28
Epidemic cerebrospinal meningitis,	1
German measles,	5
Lobar pneumonia,	1
Measles,	20
Scarlet fever,	25
Smallpox,	1
Typhoid fever,	8
Whooping cough,	1

The *diphtheria* outbreaks totaled 441 cases, with 77 as the largest single instance.

In the case of *measles*, 10,624 cases were reported from 33 cities during the months of February, March and April. Approximately 29,000 cases were reported from the State during the year.

Scarlet fever appeared in 25 outbreaks, with a total of 600 cases. The largest, composed of 124 cases, appeared in Holliston in August and September, and was milk-borne.

An outbreak of six cases of *smallpox* appeared in Marlborough in February, due to the admission of an unrecognized case into a general hospital.

At Camp Devens in Ayer a large number of malaria carriers was found, and in pools in surrounding towns numbers of anopheles mosquitoes. This combination threatened an outbreak of malaria in the civil population unless prevented. The Governor and Council appropriated $1,000 to be applied in drainage work for this purpose.

The overshadowing epidemic of the year was influenza. On or about August 28 reports were received of cases among naval men at Commonwealth Pier, Boston. As influenza was not reportable, information from ordinary sources was meager, but early in September the Department issued a public warning of the probable approach of a general outbreak. By September 19 the disease was firmly intrenched in a very fatal form in several towns and cities in the eastern part of the State, and investigation showed great need for doctors, nurses and hospital accommodations. These were obtained and distributed as rapidly as possible to points where the need was greatest.

The outbreak spread rapidly and covered the entire State. The only successful barrier was a strict quarantine established *well in advance* of the first appearance of the disease in the immediate vicinity, and strictly maintained. The only instances of this procedure were in certain schools and institutions. As long as they maintained a strict quarantine they escaped. With the appearance of the first case all attempt at protection by isolation or other preventive measures was ineffectual, and the usual percentage was affected.

Influenza figures are not completed at date, and can never be accurate in the matter of the number of cases of the disease. Up to December 1, there are estimated to have occurred 400,000 cases and 12,000 deaths. It is needless to report that an epidemic of this proportion, with this fatality and rapidity of extension, strained every public and private health agency, at times nearly to their limit of cohesion.

The venereal disease program, announced last year, has been launched. The addition of gonorrhea and syphilis to the list of reportable diseases became effective on February 1. From then to Decem-

ber 1 a total of 10,047 cases, 7,036 of gonorrhea and 3,011 of syphilis, have been reported to this Department. A subdivision of venereal diseases has been established. Of the 16 clinics and 3 subclinics planned, 11 clinics and 1 subclinic are in operation, and the remainder are in different stages of completion. An instance of the usefulness of work in this subject is shown in its results with persons lapsing from treatment through negligence or intent. Of 1,182 such cases, 579 were reclaimed and 338 are still being followed up, while only 265 have been lost sight of. That 579, or 50 per cent, of the most dangerous, because either careless or vicious, type of venereal cases were brought back to treatment through the guiding efforts of this subdivision is a remarkable record.

The educational side of the work has been active. A total of 98 lectures and moving-picture exhibits have been given to about 75,000 people. The film exhibit "Fit to Fight," purchased from the War Department, has been shown 54 times in 23 cities and towns to about 60,000 people.

The co-operation between this Department and the local boards of health, the courts and the military and civil organizations and societies engaged in different phases of the problem has been very complete and satisfactory.

A subdivision of tuberculosis has been established. The volume of work involved in the general supervision of the 20,000 or more active cases of this disease in the State made such a specialization advisable.

The construction of county tuberculosis hospitals was abruptly halted by the action of the capital issues committee. They decreed that, as a measure for the conservation of capital, work on the Essex and Middlesex institutions should entirely cease, and after delays they permitted the work on the Barnstable, Bristol, Norfolk and Plymouth institutions to proceed. Our whole protective program has therefore been delayed for approximately a year, although our tuberculosis death rate is still increasing and the need for these institutions is urgent.

A survey of Barnstable County to determine the prevalence of tuberculosis, made in April, proved the local disease demand for a hospital.

A survey of the city of Cambridge was interrupted by the influenza epidemic, but has been resumed.

The dispensaries in the Northeastern District have all been visited by a representative of this subdivision for the purpose of standardizing their records. During this year it is planned to cover the entire State with this work.

About 1,100 positive and suspected cases were reported by local exemption boards and military cantonments. Of these, 615 were brought to our attention and placed under treatment very much

earlier by this procedure than they would have been in ordinary circumstances. The others were already on record.

The intensive campaign against typhoid fever has been continued with success. Eight carriers have been located and guarded against. During the past year 406 less cases were reported than during the year previous. The case incidence was 0.29 in each thousand population as compared with 0.4 in each thousand during the previous year. Fall River continues to have more than its share of cases, but has reported less than 60 per cent of its last year's record.

One milk-borne outbreak, totaling 32 cases, occurred in Marlborough in August and September. This was found to be due to a carrier employed in connection with a milk route.

This year has seen the addition of eight nursing assistants to our field force, one to each health district. They have been at work for only three months. Their value as an organizing and directing force was very clearly demonstrated during the influenza epidemic.

The scope of the work of the District Health Officers and their nursing assistants continues to broaden, — to get away from detail and specialization and into generalization. Their influence in their districts is being felt and appreciated more and more. Their duties are arduous and trying, and we are proud of their record.

The number of examinations made in the diagnostic laboratory was approximately 18,800, about 3,500 less than during the previous year. School outbreaks of diphtheria were markedly fewer, and the number of examinations correspondingly less. Of the 396 cultures for typhoid examined, 36 were positive and 8 carriers of the disease were located. This increased our knowledge and power over the sources of typhoid fever, and our typhoid rate this last year seems correspondingly lower.

The determination of type in pneumococci has been carried on steadily. There have been 997 specimens of sputum examined, resulting in the type determination in 683 instances, and proving the absence of pneumococci in 314.

The laboratory staff has instructed 20 visitors in various branches of the work during the year, and has also given a war service course to eight college graduates from Smith, Simmons and the Massachusetts Institute of Technology.

Division of Food and Drugs.

H. C. Lythgoe, Director.

The actual work of the Division of Food and Drugs has been greater during 1918 than during the preceding year. During the eleven months of 1918, 10,724 samples have been examined; 324 cases

have been prosecuted, the total fines amounting to $7,900.10; and 75 confiscations have been made, the weight of confiscated articles amounting to 96,864 pounds.

There were a number of cases of adulterated milk shipped into the Commonwealth from other States, and a number of violations of the laws regarding the sale of eggs. It was found that, in general, egg dealers were selling eggs of all descriptions as fresh eggs, and the false advertising law was used successfully in curbing violations of this character.

A special investigation of the character of meat used in sausage factories proved that it was much better than that used in former years.

An investigation was made of the character of ice cream sold; and while the percentage of fat corresponded to the requirements of law, it was found that the samples taken were very light in weight, due to the introduction of large amounts of air during the process of manufacture. Ice cream is sold by volume and not by weight, and air is naturally the cheapest of ingredients.

At the request of the district attorney of Middlesex County a special investigation was made of the water used in ice-cream parlors for moistening the scoops. The amount of bacteria found in the water was surprisingly low, in no case reaching the limit set by local board of health regulations concerning the maximum figures for bacteria content of ice cream.

The Department, through the Division of Food and Drugs, was called upon to co-operate to some extent with the Food Administration, particularly in connection with cold-storage extensions.

Considerable trouble was experienced in placing arsphenamine manufacture upon a commercial basis. At the present time all difficulties have been overcome, and nearly 3,000 ampoules have been distributed, with no reports of detrimental physiological action. The processes of manufacturing and bottling the drug have been changed, making an increased yield possible. Present indications are that the Division will be able to turn out 120,000 doses during the coming fiscal year. Special care is being taken in having duplicate physiological tests of the product made in separate laboratories, so that the danger of a mistake in the final testing is reduced to a minimum.

Division of Biologic Laboratories.

M. J. Rosenau, M.D., Director.

The work of the Division of Biologic Laboratories was carried out in the face of unusual difficulties during the fiscal year of 1918. This was caused by increased activities, increased demand for products, changes

in personnel, the difficulty in obtaining certain supplies, and the strain of finance caused by war conditions. Several emergencies had to be met, which taxed the capacity of the laboratories to their utmost. There was a sudden and unusual demand for diphtheria antitoxin during the summer time, for vaccine virus in the spring, and for anti-meningitis serum during the cold season. The principal new activity of the Division consisted in the testing of arsphenamine.

The changes in personnel at the Antitoxin and Vaccine Laboratory at Forest Hills, caused by war conditions, became a matter of deep concern when the nature and importance of the products made at that laboratory were taken into account. The financial situation was bothersome during the fiscal year, for it soon became evident that even with the strictest economy it would be impossible to make the budget meet the increased cost of labor and supplies.

As an example of the difficulties the laboratories had to contend with, we may cite the fact that it has become impossible to obtain dialyzing paper for the purpose of concentrating diphtheria antitoxin. This paper was formerly made in Belgium, and since this source of supply has been cut off it has become impossible to obtain paper of equal quality.

The following is a summary of the work done both at the Antitoxin and Vaccine Laboratory at Forest Hills, and the Wassermann Laboratory at Boston: —

	1918.	1917.
Vaccine virus (doses),	209,835	180,521
Typhoid prophylactic (doses),	37,322	71,893
Paratyphoid vaccine (doses),	2,850	2,723
Typhoid-paratyphoid (doses),	27,315	16,143
Diphtheria antitoxin (doses),	206,937	218,604
Antimeningitis serum (bottles),	4,035	2,005
Pneumococcus serum: —		
Type I (bottles),	363	60
Type II (bottles),	366	97
Schick outfits (bottles),	6,400	3,100
Toxin antitoxin (doses),	426	-
Wassermann tests,	29,000	28,000
Complement fixation tests for gonococcus,	1,200	-
Tests for glanders,	1,051	1,330
Tests for rabies,	56	67
Pathological examinations,	25	13

The Division has again co-operated with the Bureau of Animal Industry in making diagnostic tests for glanders, rabies and other infections of animals.

The Division has assisted both the army and navy in different ways; thus 2,732 naval aviators were tested for the Wassermann reaction, with 12 positives; and 1,200 were subjected to the complement fixation test for gonococcus infection, with 7 positives. We also furnished to some of the army and navy establishments in Massachusetts quantities of diphtheria antitoxin, antimeningitis serum, vaccine virus and other products to meet special needs.

Perhaps the most important activity of the Wassermann Laboratory has been in connection with the standardization of the Wassermann technique. Representatives from eleven of the largest laboratories in the State were called together by the Commissioner of Health. The technique used at the Wassermann Laboratory was adopted as a standard method of procedure for all laboratories performing this test throughout the Commonwealth. The Wassermann Laboratory has also been able to aid in the State venereal program in various ways.

The work of the Division has been increased, the number of its products multiplied, and the quality of its service improved.

Division of Hygiene.

M. E. Champion, M.D., Director.

Chief among the outstanding pieces of work of the year was that accomplished through the child conservation committee of the Department. The appointment and organization of this committee was described in last year's report. It is difficult to summarize this work, but in brief an attempt was made through the eight nurses employed by the committee to make a survey of the child conservation resources of every city and town in the State, with the exception of some of the small towns having no particular problem to face. Figures compiled Sept. 1, 1918, show that 220 towns were surveyed, including 92 per cent of the population of the State.

The weighing and measuring campaign, though not carried on directly by this Department, was encouraged as an aid in publicity for child welfare. Incomplete reports give 129 cities and towns as having carried out the test. A rough estimate of the concrete results of the children's year campaign to Sept. 1, 1918, may be given as follows: —

Amount of money appropriated by cities and towns,	$25,680
Amount of money raised by private organizations,	28,250
	$53,930

Amount of money fairly sure in prospect,	$11,500
	$65,430

Number of nurses actually employed,	31
Number of nurses authorized but not secured,	15
	46
Number of nurses fairly sure to be placed,	5
	51

The policy of the entire year's campaign has been to stimulate the different municipalities to take care of their own problems, at the same time lending them every assistance possible. Occasionally, nurses have been loaned for a longer or shorter period to help in the organization of new work in some city or town.

Our prenatal letters have apparently filled a real need. Replies from mothers are frequently received voicing their appreciation. Approximately 1,700 sets of the letters have been sent out this year.

During the greater part of the summer, through the courtesy of Miss Donham of the Garland School for Homemaking, this Division maintained an exhibit on a food trolley which traveled over the eastern part of the State. A great many people were reached in this way at comparatively little expense.

Various new pamphlets were issued, mostly on nutritional subjects, reprinted from the monthly bulletin. One on the care of the baby in hot weather proved very effective. An outline of a course on child welfare, designed for use in vocational schools for classes of girls and young women, was prepared with the hearty approval of the director of vocational work of the State Board of Education.

The monthly bulletin has been altered in form and appears under a new name, "The Commonhealth." A special double number of this was issued for September–October, dealing with the problem of child conservation in its various aspects.

Our lecture service was continued during the year, a total of 587 lectures having been given. This number would have been much larger if it had not been for the absorption of the public in war problems of other kinds, and for the interruption to our work caused by the influenza epidemic.

The policy has been continued of holding health weeks throughout the State, at which our exhibits are shown and talks on various health problems are given by different members of the staff. A nurse accompanies the exhibit. Her most important duty is to reach the mothers and children through demonstrations and talks on child hygiene.

Future Office and Laboratory Space for the Department.

As was foreseen at the time of occupancy, the present administration quarters of the Department have already proved too small. The rapid development of the venereal disease campaign has resulted in the employment of a personnel for whom no adequate quarters are available. The removal of many of the temporary war emergency offices from the State House has relieved the strain of demands for space upon the State House Commission. They have promised to endeavor to make such necessary adjustments within the near future as will insure adequate office space for the Department.

In the last annual report the Commissioner commented upon the request of the Harvard Corporation to the Department to vacate as early as possible the building at Forest Hills now occupied by the Antitoxin Laboratory, but owned by the University and desired for their own use.

During the year the special committee on laboratories of the Department has sought in all directions to find a suitable tract of land near Boston for this purpose. The task is a most difficult one. Certain fundamental requirements as to accessibility, availability of gas, electric current and water service are absolutely basic in a problem of this sort. On account of the number of animals necessary, considerable acreage beyond that needed for the buildings is very necessary to furnish exercise ground for horses, etc.

After looking at all sites suggested or found, the committee decided that the two most favorable sites in the vicinity of Boston, aside from all questions of present ownership, where land suitable to the purpose existed, were on the grounds of institutions already belonging to the State. One of these sites, and the best for our purposes, the Boston State Hospital for the Insane, is stated by the Commission on Mental Diseases to be already so completely pre-empted for buildings in their plans for future expansion that no space is available.

The problem is a most pressing one, regardless of the insistent demands of the Harvard Corporation for our vacating the present quarters. Ordinary foresight and prudence demand that a much larger number of horses should be kept for the production of anti-meningitis serum and diphtheria antitoxin, but no space is available in the present stables for additional horses.

Furthermore, the policy of housing our Wassermann Laboratory as a rent-free tenant at Harvard Medical School, while most generous on the part of the University and of tremendous service to the State, is one that cannot in fairness to the University be expected to be continued indefinitely.

The separate laboratories maintained at the State House and at Lawrence by the Department for the water and sewerage investigations should also eventually be housed in the same building as the biologic laboratories.

Prevention and Control of Cancer.

An appropriation of $3,000, to be expended for the prevention and control of cancer, is being asked for. Such an expenditure is justified for the following reasons: —

1. *The Importance of the Work.* — There were 4,051 deaths in Massachusetts in 1917 from cancer. In this State 1 in every 8 women and 1 in every 14 men over the age of forty die of cancer. A large proportion of these deaths might be prevented by early treatment.

2. *The Desirability of Scientific Accuracy in Diagnosis.* — It is important to know after an operation has been performed whether or not the patient really had cancer. This can be definitely decided only by pathological examination. An apparently benign growth may prove, on careful microscopic examination, to be cancerous. If this is determined at once a more extensive operation can often save a life which otherwise would be sacrificed through ignorance of the facts.

3. *Education of Public.* — Such a service enables surgeons to make more accurate diagnosis by having their results checked up by microscopic examination. It also makes the public appreciate the need of careful medical supervision to detect early signs of cancer, in that the value of such supervision can be proved by the concrete evidence of the laboratory. Anything which tends to get the patient to the physician early, and which tends to get the physician to take no chances on suspicious growths, inevitably will help to reduce our cancer death rate.

For the past two years the Cancer Commission of Harvard University has furnished both space and expert cancer microscopists to the Department for the free examination of any suspected pathological tissues for hospitals and surgeons throughout the State.

The Commission now feels that the life-saving value of this work has become sufficiently well demonstrated, and that the State should assume a part of the expense. I feel that their contention is only fair, and therefore recommend that $3,000 be appropriated as remuneration in part for the expert services of the cancer laboratory of the Harvard Commission, and for extending the facilities of this laboratory to the physicians and surgical hospitals of the State.

4. *Economy.* — Under the scheme proposed the Department can save the overhead expenses of a laboratory of its own because of the

close co-operation possible between the State Department of Health and Cancer Commission of Harvard University, whereby laboratory facilities available to the latter are placed at the service of the State Department of Health.

Water Supply Problems.

In the opinion of the State Department of Health the time has come when it is necessary that a comprehensive and thorough investigation be made of the water-supply needs of the inhabitants of the Commonwealth. Many of our cities and towns having inadequate and unsatisfactory water supplies are forced to seek new sources in isolated efforts.

The contrast between the water-supply conditions of such municipalities and of those supplied with metropolitan water is so marked, and the waste of piecemeal investigation and improvement so great, that the Department of Health has entered into a conference with the Metropolitan Water and Sewerage Board to consider the situation. As a result of this conference a resolve has been prepared authorizing an investigation by the State Department of Health and the Metropolitan Water and Sewerage Board, acting jointly, of the water-supply needs of the Commonwealth, which will be submitted to the Legislature of 1919.

It is interesting to note in this connection that in the original investigation as to the water-supply needs of Boston and neighboring cities and towns, which resulted in the establishment of the Metropolitan Water Board, it was calculated by the engineers of the State Board of Health in their report of 1895 that in twenty years' time, if the growth of population continued at the same rate, the whole question of the water supply would need reconsideration from the standpoint of enlarging the possible available supplies and increasing the number of communities to be furnished metropolitan water. In view of the conditions in many of the districts of the State, it is important that a thorough study be made of the whole problem of water supply in all portions of the State, but especially in the areas herein described, in order that an ample supply of good water may be made available for the use of the inhabitants at all times, and that the danger of shortage of water supply or of injury to the public health from the use of inferior water supplies may be avoided. These questions are of the utmost importance. A public water supply under modern conditions is by far the most important of all public services. Upon it depends the means for extinguishing fires, all too common under our New England conditions of building. No article of diet is as essential to the health of the individual as pure water, and none is capable of causing more

widespread and serious injury to the public health than drinking water containing injurious substances. A pure water is also valuable for mechanical uses and for many manufacturing purposes, and the possession of or a right to have an excellent water supply is a most important asset to any municipality. The standing of Massachusetts water supplies has thus far been high, and it is important that this standard be maintained. With the rapid growth of population in the metropolitan district, and in other great industrial areas in the State, the enlargement of local water supplies is constantly necessary, and the available drainage areas suited to the purpose of providing public water supplies are becoming measurably restricted.

There will undoubtedly arise in the near future serious questions as to grants of new sources of water supply in many parts of the State, and the interests of all concerned require that the selection and development of new sources shall be made in the light of full information as to circumstances affecting the sources which are found to be available, and their appropriateness for the purpose for which their use is proposed. A thorough study of the whole problem would furnish the information necessary for the selection of the most appropriate sources of water supply for the various municipalities, with due regard for the needs and interests of the other cities, towns and persons which may be affected thereby. Much information of value in connection with such an investigation, including records of rainfall, flow of streams, yield of watersheds, the character of their waters and means for their protection, has been accumulated by this Department in connection with its general oversight of inland waters under existing laws, and much additional information as to water supply in a large part of the State has been gathered by the Metropolitan Water and Sewerage Board in an experience of many years in the construction, maintenance and operation of the metropolitan waterworks. It would undoubtedly be advantageous to combine the two departments in such an investigation as is here proposed, thus making the experienced engineering staffs of these departments available for the general direction of the work, and it is probable that, notwithstanding the far greater number of sources requiring careful consideration, and the greater cost of such work at the present time, an appropriation no greater than that which was necessary in connection with the original metropolitan water supply investigation will be sufficient for the work. The Department therefore recommends an appropriation of $50,000 for carrying out the work herein proposed, which can probably be completed within two years.

In water-supply questions it is peculiarly necessary that far-seeing plans be made as to future development. Ultimate plans for future

conservation of water supplies in Massachusetts should rest upon the premise of the possible maximum future population of the State being limited by the possible future extension of adequate water supplies. From this it follows that every possible future source should be studied and methods for its conservation put into effect.

School Hygiene.

As a result of the draft examinations we now know that from one-quarter to one-third of those examined were suffering from physical defects. Most of these defects could have been corrected or prevented in childhood if proper medical examinations, followed by appropriate hygienic medical or surgical treatment, had been carried out, and proper physical education instituted. In this, as in other things, foresight is better than hindsight, and hindsight better than no sight at all.

To forestall such a state of affairs in the future, thus insuring that our children be physically fit, whether for tasks of peace or of war, is the present duty of those interested in the health and education of the child. Two methods of attack have been proposed. One is through extension and standardization of the present medical inspection law, which would make it obligatory on all cities and towns to furnish, to an extent necessary to properly carry out the work, school physicians and nurses and to provide modern teaching of hygiene. The other is through the universal establishment of instruction in physical education, so called, carried out consistently throughout the period of school attendance, and properly adjusted to individual needs and capacity of the child as determined by the periodic physical examinations.

Both these methods of attacking the problem depend for success on close co-operation between the two agencies interested, namely, the departments of health and education. The execution of the provisions of any such law or laws might well be in the hands of the educational authorities. Rules and regulations, on the other hand, should be promulgated only after the concurrence has been obtained of the other department most interested, namely, that of health.

In view of the great need for uniformity throughout the State, if such methods of school hygiene are to be effective, there should be central control provided for in any laws enacted on this subject; and under the circumstances, this control should rest with the State Board of Education and the State Department of Health.

Housing.

Housing conditions in this State are being investigated by a housing board, appointed in July, 1918, by the State Commissioner of Health. In view of the shifting of industries due to war conditions, the in-

creased cost of building, the scarcity of suitable dwellings in many cities and towns, and the growing public interest in the housing problem, it has been thought desirable to have this Department secure data bearing upon the fundamental relation between housing and health, in order that it may be prepared to give advice on this important matter. This investigation has involved not only general studies but local studies of density of population per acre and per building in representative cases, the operation of existing sanitary regulations, and the sufficiency or otherwise of available tenements.

The board has as chairman Prof. George C. Whipple of Harvard University, member of the Public Health Council, State Department of Health, its other members being drawn from the medical and engineering services of the Department, as follows: —

Dr. John S. Hitchcock, Director of the Division of Communicable Diseases.
Dr. C. E. Simpson and Dr. R. B. Sprague, District Health Officers.
Mr. X. H. Goodnough, Chief Engineer and Director, Division of Sanitary Engineering.
Mr. John S. Hodgson, Sanitary Engineer, Secretary.

The board was represented by the secretary at the recent Boston Convention of the National Housing Association.

Medical Social Service.

The recent epidemic of influenza has brought to the front the great need of some co-ordination and extension of the agencies designed to help persons temporarily unable to care for themselves through sickness. These persons do not need charity in the ordinary sense of the term, but temporary assistance may prevent them from drifting into the pauper class.

Medical social service is not an untried thing. The Massachusetts General Hospital and many other institutions have proved its worth. It is non-existent, however, in most of the smaller places, and nowhere are the different agencies properly co-ordinated.

Health departments in the past have not recognized, as a rule, any obligation in this direction. It is a serious question whether it is not a proper function of health departments, merely as a matter of preventive medicine, to start those temporarily disabled on the road toward health and usefulness, and away from chronic ill health and the pauper state. A careful study of existing agencies for medical social service and their relationship to the community should help to determine the above point and to clear up the subject in general.

Plumbing.

Because of the many questions continually arising in relation to the practice of plumbing, the adequacy of plumbing regulations, and the general problem of the distribution of water and removal of liquid wastes within buildings, a plumbing board was appointed by the State Commissioner of Health in September, 1918.

The board consists of Prof. George C. Whipple of Harvard University, representing the Public Health Council; Mr. James C. Coffey, member of the Board of Examiners of Plumbers; Mr. E. C. Kelley, representative of the Massachusetts State Association of Master Plumbers; and Mr. Thomas M. Wilson, representative of the New England Association of Plumbing Inspectors. The duties of this board are to consider the whole problem of plumbing laws in order to ascertain the feasibility of establishing a simplified and uniform code of plumbing laws for the entire State.

Appropriations and Expenditures.

Regular Appropriations.

Division of Administration.

Appropriation,	$28,000 00
Credit by transfer from venereal diseases,	570 00
Credit by rebate on mileage returned,	43 97
Credit by cash returned to treasury,	8 81
	$28,622 78
Salaries,	$18,636 47
Traveling,	757 13
Express,	177 79
Printing and binding,	4,267 33 [1]
Books and subscriptions,	215 45
Advertising,	17 38
Stationery, maps and blue-prints,	471 82
Postage and postal orders,	2,145 42
Telephone and telegraph messages,	354 48
Typewriting supplies and repairs,	135 21
Sundry office supplies,	91 86
Extra services,	1 00
Messenger,	212 88
Miscellaneous,	91 04
Total,	$27,575 26
Unexpended balance,	1,047 52
	$28,622 78

[1] Includes annual report.

Division of Hygiene.

Appropriation for the year ended Nov. 30, 1918,	$24,500 00
Credit by rebate on mileage returned,	48 03
	$24,548 03
Salaries,	$10,738 22
Traveling	4,422 58
Express,	145 46
Printing and binding,	5,222 54
Books and subscriptions,	60 80
Advertising and educational work,	1,249 46
Stationery, maps and blue-prints,	141 86
Postage,	704 22
Telephone and telegraph,	148 46
Typewriting supplies and repairs,	246 99
Extra services,	202 05
Laboratory supplies,	28 94
Miscellaneous,	98 16
Total,	$23,409 74
Unexpended balance,	1,138 29
	$24,548 03

Expenses under the Provisions of the Act to provide for the Establishment of Health Districts and the Appointment of State Inspectors of Health (Chapter 537, Acts of 1907, Chapters 405 and 543, Acts of 1910, Chapters 603 and 609, Acts of 1911) for the Year ended Nov. 30, 1918.

Appropriations,	$65,850 00
Credit by cash returned to treasury from various sources,	266 33
Credit by salaries transferred to appropriation for venereal diseases,	824 97
	$66,941 30
Salaries,	$45,259 46
Traveling,	8,345 11
Express,	33 69
Printing,	726 15
Books and maps,	81 49
Postage,	1,634 67
Typewriting supplies and rental,	151 37
Extra services,	1,199 21
Telephone and telegraph,	464 11
Office supplies and stationery,	470 55
Laboratory and experimental work,	20 00
Laboratory supplies,	593 05
Mailing cases,	283 46

Purchase of animals,	$189 60
Food for animals,	19 23
Labor,	892 75
Miscellaneous,	50 56
Total,	$60,414 46
Unexpended balance,	6,526 84
	$66,941 30

Expenditures for the Production and Distribution of Antitoxin and Vaccine for the Year ended Nov. 30, 1918.

Appropriation,	$40,000 00
Credit by amount paid out on account of United States Venereal Trust,	519 77
Credit by refund to treasury on account of freight,	3 50
	$40,523 27

Salaries,	$18,515 90
Apparatus, chemicals and laboratory supplies,	5,813 79
Traveling,	204 79
Express,	115 91
Typewriting supplies, books and stationery,	148 48
Printing,	731 85
Purchase of animals,	2,677 80
Shipping,	1,486 26
Services of veterinary surgeon and saddlery,	27 75
Food for animals,	4,514 60
Rental of telephone, messages and postage,	456 06
Extra services,	252 88
Water, gas, electric lighting and heating,	1,299 57
Labor and materials,	1,646 67
Ice,	417 95
Rent,	2,058 32
Miscellaneous,	438 87
Total,	$40,807 45

Expenditures under the Provisions of the Food and Drug Acts for the Year ended Nov. 30, 1918.

Appropriation,	$33,000 00
Credit by rebate on mileage returned,	85 30
Credit by transfer from United States Venereal Trust,	60 56
	$33,145 86

Salaries,	$26,739 75
Apparatus and chemicals,	737 85
Traveling,	3,093 37
Purchase of samples,	635 20
Express,	75 91
Printing,	281 69
Books, maps and stationery,	164 11
Telephone, telegraph messages and postage,	417 69
Sundry laboratory supplies,	190 99
Typewriting supplies and repairs,	79 52
Services, cleaning laboratory,	121 00
Advertising,	11 95
Branding outfits,	37 71
Miscellaneous,	7 65
Total,	$32,594 39
Unexpended balance,	551 47
	$33,145 86

For carrying out the Provisions of the Act to protect the Purity of Inland Waters, for the Examination of Sewer Outlets, and for the Examination of the Sanitary Condition of Certain Rivers and Watercourses.

Appropriation for the year ended Nov. 30, 1918,	$56,800 00
Credit by cash returned to treasury from different sources,	403 57
Credit by transfer from appropriation for domestic water supplies,	492 80
	$57,696 37

Salaries,	$45,074 18
Apparatus and materials,	2,389 87
Traveling,	4,708 47
Express,	1,071 10
Maps, blue-prints and books,	288 13
Printing and binding,	304 87
Stationery, drawing materials and typewriting supplies,	315 20
Telephone and telegraph messages and postage,	410 13
Services, collecting samples and reading gauges,	386 67
Labor,	76 96
Rent,	150 00
Miscellaneous,	124 05
Total,	$55,299 63
Unexpended balance,	2,396 74
	$57,696 37

State Examiners of Plumbers.

Appropriation for the year ended Nov. 30, 1918,	$4,800 00
Salary of secretary,	$2,000 00
Examiners' wages,	565 00
Traveling,	551 06
Express,	29 14
Printing,	158 32
Postage,	195 02
Books, stationery and typewriting supplies,	18 31
Plumbers' materials,	4 00
Extra services,	940 00
Cleaning,	25 80
Office supplies,	1 00
Telephone and lighting,	91 44
Miscellaneous,	6 75
Total,	$4,585 84
Unexpended balance,	214 16
	$4,800 00

For carrying out the Provisions of the Act relative to the Prevention of Ophthalmia Neonatorum (Chapter 458, Acts of 1910).

Appropriation for the year ended Nov. 30, 1918,	$1,000 00
Printing,	$5 39
Ophthalmia outfits,	970 24
Total,	$975 63
Unexpended balance,	24 37
	$1,000 00

SPECIAL APPROPRIATIONS.

Expenditures under the Provisions of the Act for the Prevention and Suppression of Syphilis (Chapter 47, Resolves of 1916) for the Year ended Nov. 30, 1918.

Appropriation,	$10,000 00
Expended in 1916 and 1917,	4,931 98
Balance,	$5,068 02
Salaries,	$1,041 67
Apparatus and laboratory supplies,	1,783 58

Chemicals,	$1,422 80
Testing,	187 50
Animals,	9 90
Packing,	420 73
Printing,	81 09
Travel,	53 80
Miscellaneous,	66 90
Total,	$5,067 97

Expenditures from June 1 to Nov. 30, 1918, for the Prevention of Venereal Diseases.

Appropriation,	$30,000 00
Salaries,	$4,927 97
Traveling,	174 70
Postage,	990 00
Telephone and telegraph,	3 09
Books and stationery,	148 70
Printing,	1,805 11
Laboratory supplies,	1,306 85
Office supplies,	7 95
Typewriting supplies,	125 10
Clinics,	7,000 00
Educational,	2,793 39
Labor and materials,	141 03
Animals,	68 00
Miscellaneous,	18 10
Total,	$19,509 99
Unexpended balance,	10,490 01
	$30,000 00

Expenditures under the Provisions of Chapter 58, Resolves of 1918, for Report of a Plan for the Disposal of Sewage in the Town of Ayer.

Appropriation,	$800 00
Salaries,	$435 97
Traveling,	298 59
Express,	84
Maps and blue prints,	8 12
Drawing materials and office supplies,	4 35
Total,	$747 87
Unexpended balance,	52 13
	$800 00

Expenditures under the Provisions of Chapter 24, Resolves of 1918, for the Investigation of Hale's Brook.

Appropriation,	$1,000 00
Salaries,	$773 15
Traveling,	96 64
Express,	1 34
Maps and blue prints,	10 83
Drawing materials,	11 50
Special investigation,	30 00
Total,	$923 46
Unexpended balance,	76 54
	$1,000 00

RECAPITULATION.

Regular Appropriations.

	Appropriation.	Expended.
For the Division of Administration,	$28,000 00	$26,922 31
For the Division of Hygiene,	24,500 00	23,361 71
For the Division of Communicable Diseases,	65,850 00	59,323 16
For the prevention of ophthalmia neonatorum,	1,000 00	975 63
For the Division of Food and Drugs,	33,000 00	32,428 46
For the production and distribution of antitoxin and vaccine,	40,000 00	40,284 18
For water supply and sewage disposal,	56,800 00	54,403 26
For the State Examiners of Plumbers,	4,800 00	4,585 84
Totals,	$253,950 00	$242,284 55

Special Appropriations.

For the prevention and suppression of syphilis, balance from 1917,	$5,068 02	$5,067 97
For the prevention and suppression of venereal diseases,	30,000 00	19,509 99[1]
For report of a plan for the disposal of sewage in the town of Ayer,	800 00	747 87
For the investigation of Hale's Brook,	1,000 00	923 46
Totals,	$36,868 02	$26,249 29

[1] June 1 to November 30.

EUGENE R. KELLEY,
Commissioner of Health.

SUPPLEMENT.

Division of Sanitary Engineering.

X. H. Goodnough, *Director*.

REPORT OF DIVISION OF SANITARY ENGINEERING.

During the past year the work of the Division has been greatly hampered by the fact that nearly all of its engineering force entered the military service of the United States, a total of nineteen in all having entered the service directly from this Division, leaving but three engineers formerly connected with the Department to carry on its work. It has been practicable, however, to secure the assistance of one or two experienced engineers not within the draft age to aid in carrying out the work of the Division in the oversight and care of inland waters, and advising cities, towns and others relative to water supplies, drainage, sewerage and matters relating thereto.

The applications for advice received by the Department for the approval of plans for water and sewerage works during the past year have numbered 147, the same as in the previous year. Of these applications, 40 were in relation to public water supplies, 60 to private water supplies, 3 to sources of ice supply, 22 to drainage, sewerage and sewage disposal, 7 to pollution of streams and 15 to miscellaneous matters.

Very little work has been undertaken by cities and towns during the year in the introduction and extension of water supplies and sewerage systems, and that only in cases of emergency; but an unusual number of applications has been received relative to the water supply and sanitation of military and other camps.

General Water Supply Situation and Necessity for Present Action for the Protection and Development of Available Additional Sources.

Some twenty-five years have elapsed since the investigations with reference to a metropolitan water supply were begun by this Department under direction of the Legislature, and the works then recommended and subsequently constructed have now been in use for many years. They were designed on broad lines suited to meet the needs of the metropolitan district as then created, and capable of a gradual development to serve the areas for which they were intended to provide for a very long time in the future. These works are serving their purpose admirably, are providing a most excellent water supply in ample

quantity at a very reasonable cost, and are capable of great extension to meet future needs at a moderate outlay as compared with the cost of the original works, thus insuring to this district, if future management shall be like the past, an ample supply of excellent water at a gradually diminishing cost.

In the years that have elapsed since the metropolitan district was established, other municipalities, both in its immediate neighborhood and elsewhere, have reached the point where their local water supplies are either unsatisfactory or unsuited to much further development than that which will meet the needs of the immediate future, and the question of providing water in many of these areas is rapidly becoming a serious one. In certain of these districts there are sources which appear capable of development into excellent water supplies at moderate expense, if set apart for such use in reasonable season, but which may become objectionable on account of cost or for other reasons if their acquisition is too long delayed.

Prominent among these districts is a large area in southeastern Massachusetts, comprised chiefly within the watershed of the Taunton River and certain small watersheds adjacent thereto, draining southerly into the sea and containing the cities of New Bedford, Fall River and Taunton, to which attention has already been called in a previous report. Throughout the greater part of this region the conditions for obtaining municipal water supplies of large capacity with reasonable economy are quite unfavorable. The streams for the most part flow through wide, flat valleys, occupied largely by swamps, and the contour of the ground is unfavorable for the construction of reservoirs of large capacity suitable for the storage of water for municipal uses; but this area contains two groups of remarkable natural storage reservoirs, one, the Lakeville ponds, so called, in the watershed of the Nemasket River, covering an area of 5,867 acres, and the other, the Watuppa ponds, in the city of Fall River, covering an area of 4,337 acres. From the former group of lakes the cities of New Bedford and Taunton obtain their water supplies at the present time, while the northerly part of the latter group supplies the city of Fall River. For the protection of their water supplies these cities have from time to time acquired lands about their sources which now amount in the aggregate to a very large area, but, while some of the sources are well protected in this way, others remain open to settlement, and, unless the control of these sources is secured in the immediate future, it may become impracticable to protect them thoroughly at reasonable cost. Under these conditions, the municipalities in this region, or some of them, may be forced to use polluted or inferior waters, depending for the improvement of such waters and the protection of the public health upon filtration or

such other treatment as may be found necessary; or it may be necessary to supply water in these regions from other sections of the State. It seems most important to determine in the immediate future upon some plan to be followed in developing water supply in this region, whether by securing control of these lakes or otherwise, and to determine, also, whether it may be practicable to allow the use of these great ponds or a part of them, for a time at least, by the public for boating and fishing.

In the extreme northeastern section of the State the populous valley of the Merrimack River presents already a number of serious water supply problems. Included in this valley are the cities of Lowell, Lawrence, Methuen, Haverhill and Newburyport and a number of populous towns, the aggregate population of the municipalities in the valley which border the river or are situated in its neighborhood amounting by the census of 1915 to 329,536. With the exception of Groveland, which is supplied with water from the Haverhill system, all of these cities and towns maintain independent water supplies from local sources. The city of Lawrence obtains its water supply from the Merrimack River after filtration, but the supply is considered objectionable from several points of view, and the city has under consideration a plan for developing a new water supply from sources independent of the river, which would require a very large outlay. The city of Lowell has supplied itself for many years with ground waters obtained in two widely separated areas, one located on the northerly side of the Merrimack River west of the city, and the other in the valley of River Meadow Brook. The ground water obtained near the Merrimack River is objectionable on account of the presence of an excess of iron and manganese, and extensive works have recently been constructed for the treatment and purification of the water from this source. The water obtained from the valley of River Meadow Brook south of the city contains an excessive quantity of carbonic acid, and acts strongly upon the lead service pipes through which it is delivered to consumers. A serious epidemic of lead poisoning resulted from the use of this water several years ago, and the city has been warned to discontinue its use, unless the water is so treated as to remove the substances which act most seriously upon lead pipes. The city has found it impracticable in recent years to provide sufficient water without using this supply, but treatment works have not yet been provided. The water supply of Methuen is inadequate and unsatisfactory, nor does there appear to be a suitable source available for this city, unless in conjunction with one of its neighbors. The quality of the water supplied in Amesbury is objectionable, while the water supplies of some of the other municipalities are apparently incapable of further economic

development. The question of additional grants of water supply sources in this region will undoubtedly soon come up, and the best interests of all require a thorough study of the water supply needs of the whole valley before special rights are granted in any of the limited number of sources that remain available for water supply uses in this region.

Another district in which the water supply situation has again become serious is in the southern part of Essex County and the region of the Ipswich River valley. Legislative rights to water supply from the Ipswich River or its tributaries have already been granted to the cities and towns of Reading, Lynn including Saugus, Peabody, Danvers including Middleton, Salem and Beverly, and rights in this river will doubtless eventually be required by other towns in this region. The rights already granted in this river are limited, and a demand for their extension is inevitable. In this case the Department has already been authorized to study the problem of the use of the surplus summer flow of this river, and a small appropriation was made therefor at the last session of the Legislature; but the larger question of storage is also involved, and a further study of the whole question of water supply development in the territory depending upon this river should be made at the earliest practicable time if it is to be completed in season to meet the growing demand for an increased water supply in this district.

While the water supply problem is most serious in the districts already mentioned, similar questions have arisen or are likely soon to arise in other areas, which will involve a thorough investigation for their proper solution. South of the metropolitan district and along its borders are several towns in which the water supplies are of limited capacity, while in some of them an additional water supply is an immediate need. This group includes the towns of Norwood, Canton, Braintree, Weymouth, Hingham, Hull, Cohasset and Scituate, with possibly others in the neighborhood. Some of these towns are included within the limit of ten miles from the State House, within which the metropolitan water district can supply water without additional legislation; but to extend the metropolitan water supply piecemeal to these districts will involve a much greater expense than would be the case if several of them could be supplied together, and it is important to determine whether it is best for all of them to develop local sources further, either individually or in groups, or whether any or all of them can be supplied more economically and acceptably to all concerned from the metropolitan district. In this region, also, the sources available for further development are limited, and many of the waters are unsatisfactory for the purposes of municipal water supply.

One of the chief sources of water supply in the southwesterly section

of the metropolitan area is the Charles River valley, from the lower portion of which the cities of Cambridge, Waltham and Newton, and the towns of Weston, Wellesley, Brookline, Needham and Dedham, obtain their water supplies at the present time. In the case of Cambridge the supply is obtained from storage reservoirs on the tributary stream known as Stony Brook, while all the others obtain their water supplies by means of wells sunk in the extensive gravel beds which border this river throughout the greater part of this region. The Cambridge supply is capable of further development, but the maximum development of which it is capable will not enable it to furnish more than about 14,400,000 gallons per day, a quantity of water only 29 per cent in excess of the amount used by the city in the twelve months which ended with November, 1918. Even this development will involve a very considerable outlay. The city of Waltham has practically reached the limit of the supply of good water obtainable in the areas available to that city along Charles River. The city of Newton is already a part of the metropolitan water supply district and can use metropolitan water whenever such necessity may arise. It has thus far obtained its supply from the gravel beds available to the city in Needham. The town of Brookline obtains its water from the region above that used by the city of Newton, but the water is affected by mineral matter, and a treatment works has recently been established to improve its quality. The Dedham Water Company supplies the town of Dedham with water taken still farther upstream than the region in which the Brookline works are situated. The water supplies of Wellesley and Needham are obtained from the valleys of tributary streams in the immediate neighborhood of the main river, while that of Weston is obtained from the valley of Stony Brook. The region from which these water supplies are obtained borders the metropolitan district, and the population is increasing quite rapidly in the neighborhood of many of the areas from which these water supplies are drawn. It is obvious that there will be increasing difficulty in the future in securing in these areas waters of satisfactory purity, while the supply is so limited in some cases that additional sources will soon become necessary.

North of the metropolitan water district and adjacent to it are Winchester, Wakefield and Woburn, each of which is at present provided with an independent water supply. That of Winchester is of satisfactory quality, and the quantity is likely to be sufficient until the population of the town becomes considerably larger than it is at the present time. In Woburn, also, the water supply is adequate for present needs, though its quality is affected somewhat by the population in the neighborhood of the sources of supply. In Wakefield the

water supply is obtained from a lake adjacent to the thickly populated portion of the town, and the water in its present condition is unsafe for domestic use.

There are also other regions in which the question of water supply requires careful study, especially in some of the cities and towns in the region from which the metropolitan water supply is obtained. Part of the water supply of the city of Worcester is obtained from a watershed used by the metropolitan water district, and that city is now making investigations with reference to securing an additional supply, of which it stands greatly in need. The question as to whether that city can best be supplied from the areas from which the metropolitan district now takes its supply, or in connection with the metropolitan system, or from other sources, will soon come up for consideration, and if the metropolitan sources appear to be the best available, it is not improbable that, with the addition of this large city to the draft upon the system, coupled with the possible requirements of other areas, the further extension of the metropolitan supply may soon become necessary.

In view of the conditions in many of the districts of the State as indicated in the outline herein, it is important that a thorough study be made of the whole problem of water supply in all portions of the State, but especially in the areas herein described, in order that an ample supply of good water may be made available for the use of the inhabitants at all times and the danger of shortage of water supply or of injury to the public health from the use of inferior water supplies may be avoided. These questions are of the utmost importance. A public water supply under modern conditions is by far the most important of all public services. Upon it depends the means for extinguishing fires, all too common under our New England conditions of building. No article of diet is as essential to the health of the individual as pure water, and none is capable of causing more widespread and serious injury to the public health than drinking water containing injurious substances. A pure water is also most valuable for mechanical uses and for many manufacturing purposes, and the possession of an excellent water supply is a most important asset to any municipality. The standing of Massachusetts water supplies has thus far been high, and it is important that this standard be maintained. With the rapid growth of population in the metropolitan district and in other great industrial areas in the State the enlargement of local water supplies is constantly necessary, and the available drainage areas suited to the purpose of providing public water supplies are becoming measurably restricted.

There will undoubtedly arise in the near future serious questions as

to grants of new sources of water supply in many parts of the State, and the interests of all concerned require that the selection and development of new sources shall be made in the light of full information as to circumstances affecting the sources which are found to be available and their appropriateness for the purpose for which their use is proposed. A thorough study of the whole problem would furnish the information necessary for the selection of the most appropriate sources of water supply for the various municipalities, with due regard for the needs and interests of the other cities, towns and persons which may be affected thereby. Much information of value in connection with such an investigation, including records of rainfall, flow of streams, yield of watersheds, the character of their waters and means for their protection, has been accumulated by this Division in connection with its general oversight of inland waters under existing laws, and much additional information as to water supply in a large part of the State has been gathered by the Metropolitan Water and Sewerage Board in an experience of many years in the construction, maintenance and operation of the metropolitan water works. It would undoubtedly be advantageous to combine the two departments in such an investigation as is here proposed, thus making the experienced engineering staffs of these departments available for the general direction of the work, and it is probable that, notwithstanding the far greater number of sources requiring careful consideration and the greater cost of such work at the present time, an appropriation no greater than that which was necessary in connection with the original metropolitan water supply investigation will be sufficient for the work. An appropriation of $50,000 would probably be required for carrying out the work herein proposed, which can probably be completed within two years.

Water Supply of the City of Lawrence.

In the severe winter of 1917–18, the filters of the city of Lawrence, when operated to their full capacity and supplemented as fully as possible with auxiliary supplies from Andover and North Andover, were inadequate for the filtration of all of the water required for the supply of the city, and toward the end of the winter the distributing reservoir which holds 40,000,000 gallons became nearly exhausted. It being obvious from this experience that with the increasing consumption of water it would be impracticable for the city to obtain a sufficient supply during another winter without increasing the capacity of the filters, the Department took up the matter with the Lawrence authorities at a conference on August 21, and on August 23 sent a communication to the city urging the immediate covering of the easterly section

of the old filter already partially rebuilt, and urging also that the remainder of the old filter be covered as soon as practicable in the coming season. The city after some delay undertook the work and completed the covering of about one-third of the old filter before the beginning of cold weather. With this additional filter capacity, it is probable that an adequate supply of water can be obtained by the city during the coming winter.

It has been recommended to the city government that it make still further provision for the enlargement of its filtration works early in 1919, so as to provide an ample supply of water for the next few years and discontinue the purchase of water from Andover and North Andover.

Further Water Supply from the Ipswich River.

Under the provisions of chapter 73 of the Resolves of the year 1917, the State Department of Health is authorized to investigate and report upon the advisability of granting to the cities and towns now having authority to take water from the Ipswich River for municipal uses the additional authority to use the surplus flow of said river during the months from June to November, inclusive, for water supply purposes. A report under this resolve was required to be presented to the Legislature of 1918, but the sum appropriated for the purpose having been found to be inadequate, the time within which the report should be made was extended to the second Wednesday in January in the year 1919, and an additional appropriation was made for the purpose.

Sanitary Protection of Public Water Supplies.

The usual number of cases have arisen during the year in which the advice of the Department has been sought relative to the protection of the purity of public water supplies.

Additional rules and regulations were established for the protection of the water supply of Holyoke, and rules were also made for the protection of the new water supply of Fitchburg taken from Ashby Reservoir. Amendments were made to the rules at Haverhill and Greenfield.

Early in the year a decision was handed down by the Supreme Court in a case relating to fishing in a public water supply in violation of the rules and regulations of the State Department of Health, which has an important bearing upon the protection of public water supplies. The decision is as follows: —

WATER SUPPLY — PROHIBITION OF FISHING BY MUNICIPALITIES WITHIN POLICE POWER IN ORDER TO MAINTAIN PURITY OF WATER.

RUGG, C.J. This is a complaint charging the defendant with going upon the ice of Crystal Lake and fishing therein without a written permit of the water commissioners of the city of Haverhill, in violation of rules and regulations of the State Board of Health. The pertinent part of the regulation of the State Board of Health is as follows: —

> No person shall. . . . unless permitted by a written permit of the board of water commissioners of the city of Haverhill, fish in . . . Crystal Lake. . . . so called, in the city of Haverhill. . . . said lakes . . . being used by said city as sources of water supply.

The regulation was passed pursuant to R. L., c. 75, § 113, as amended by St. 1907, c. 467, § 1, which empowers the State Board of Health to "make rules and regulations to prevent the pollution and to secure the sanitary protection, of all such waters as are used as sources of water supply," with power to delegate the granting or withholding of permits to water commissioners, subject to investigation and revision by way of appeal to the Board itself.

The delegation by the Legislature of the right to make rules and regulations is within its power. Commonwealth *v.* Sisson, 189 Mass. 247; Commonwealth *v.* Kingsbury, 199 Mass. 542. The case at bar thus is distinguished from Commonwealth *v.* Staples, 191 Mass. 384, where no power of delegation was conferred by the statute there under consideration. The power of revising the conduct of the water commissioners reserved to the State Board of Health by the statute avoids the difficulty of vesting an untrammelled discretion in a subordinate board or officer, which was held fatal to the ordinance before the court in Commonwealth *v.* Maletsky, 203 Mass. 241. Goldstein *v.* Connor, 212 Mass. 57; Stevens, Landowner, 228 Mass. 368. The regulation passed by the State Board of Health, in pursuance of the statutory authority, prohibiting fishing upon a body of water used as source of water supply for a municipality, cannot be pronounced unreasonable. It requires no discussion to demonstrate that the preservation of the purity of the water supply for the domestic uses of the people is within the police power. The absolute prohibition of fishing upon such a source of supply could not be said to be unreasonable under the circumstances here disclosed. It is not irrational for a public board to deem it likely or possible that sources of contamination and germs of disease might have a causal connection with the presence of fishermen upon the ice or waters of a supply of drinking water. Nelson *v.* State Board of Health, 186 Mass. 330; Sprague *v.* Minor, 195 Mass. 581. The case of Austin *v.* Murray, 16 Pick. 121, upon which the defendant relies, is quite distinguishable.

Exceptions overruled.

FEB. 9, 1918.

Examination of Domestic Water Supplies.

Under the provisions of chapter 90 of the Resolves of the year 1917, the State Department of Health is authorized to make sanitary examinations of water supplies used for domestic purposes and obtained from other sources than the public water supply systems, including chemical and bacterial analyses of the water when necessary. The Department is also required to advise as to the location of new domestic water supplies and the protection of such supplies in a manner similar to that now required with reference to public water supplies.

Under this resolve thirty-five sources of water supply were examined during the year, many of which were found so badly polluted as to be unfit for use. This work is a valuable one for the protection of health, especially in thickly settled communities where there is no public water supply, and it is recommended that the work be continued.

Analyses of the Water of Public Water Supplies.

Averages of Chemical Analyses of Surface-water Sources for the Year 1918.

[Parts in 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Suspended.	Chlorine.	Hardness.
Metropolitan Water District.	Wachusett Reservoir, upper end,	.26	4.17	.0027	.0149	.0023	.32	1.3
	Wachusett Reservoir, lower end,	.14	3.21	.0024	.0121	.0014	.29	1.1
	Sudbury Reservoir,	.17	3.70	.0033	.0146	.0025	.32	1.3
	Framingham Reservoir No. 3,	.18	3.84	.0030	.0164	.0032	.32	1.4
	Hopkinton Reservoir,	.54	4.09	.0037	.0217	.0034	.37	1.3
	Ashland Reservoir,	.61	4.32	.0035	.0243	.0030	.37	1.4
	Framingham Reservoir No. 2,	.69	5.13	.0050	.0266	.0035	.44	1.6
	Lake Cochituate,	.19	6.41	.0029	.0262	.0070	.73	2.5
	Chestnut Hill Reservoir,	.18	3.68	.0022	.0144	.0022	.33	1.4
	Weston Reservoir,	.17	3.52	.0027	.0167	.0037	.33	1.4
	Spot Pond,	.12	3.66	.0018	.0169	.0032	.35	1.4
	Tap in State House,	.18	3.88	.0018	.0155	.0028	.33	1.5
	Tap in Revere,	.10	3.81	.0016	.0139	.0019	.33	1.5
	Tap in Quincy,	.16	3.72	.0013	.0118	.0011	.33	1.4
Abington,	Big Sandy Pond,	.12	3.68	.0034	.0144	.0013	.79	1.1
Adams,	Dry Brook,	.25	8.14	.0050	.0143	.0024	.15	5.1
	Bassett Brook,	.05	4.34	.0020	.0071	.0011	.13	2.5

Averages of Chemical Analyses of Surface-water Sources, etc. — Continued.

[Parts in 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Suspended.	Chlorine.	Hardness.
Amherst, . .	Amethyst Brook large reservoir,	.46	3.95	.0035	.0179	.0034	.20	1.0
	Amethyst Brook small reservoir,	.19	3.39	.0066	.0163	.0041	.21	0.8
Andover, . .	Haggett's Pond, ...	.15	4.18	.0028	.0187	.0038	.40	1.6
Ashburnham, .	Upper Naukeag Lake, . .	.06	2.39	.0018	.0116	.0011	.16	0.7
Ashfield, . .	Bear Swamp Brook, . . .	.29	5.83	.0043	.0123	.0006	.18	2.9
Athol, . . .	Phillipston Reservoir, . .	.39	3.97	.0035	.0261	.0082	.19	1.2
	Buckman Brook Reservoir, .	.22	3.88	.0078	.0206	.0031	.17	1.0
	Inlet of Filter, ...	.86	4.77	.0095	.0302	.0062	.18	1.2
	Outlet of Filter, ...	.75	4.74	.0075	.0243	-	.18	1.4
Barre, . . .	Reservoir, ...	.17	4.62	.0056	.0171	.0035	.29	1.8
Blandford, . .	Freeland Brook, ...	.06	3.67	.0008	.0051	.0003	.23	1.7
Brockton, . .	Silver Lake, ...	.10	3.54	.0026	.0138	.0033	.66	0.8
Cambridge, . .	Lower Hobbs Brook Reservoir,	.15	6.64	.0061	.0235	.0038	.50	2.4
	Stony Brook Reservoir, . .	.38	6.89	.0053	.0245	.0040	.59	2.4
	Fresh Pond, ...	.22	6.96	.0098	.0263	.0066	.64	2.7
Cheshire, . .	Thunder Brook, ...	.04	10.35	.0013	.0045	.0003	.12	8.7
	Kitchen Brook, ...	.01	7.65	.0008	.0039	.0002	.08	6.2
Chester, . . .	Austin Brook Reservoir, .	.13	4.60	.0054	.0266	.0092	.13	2.0
Chicopee, . .	Morton Brook, ...	.08	3.96	.0008	.0051	.0007	.16	1.3
	Cooley Brook, ...	.28	4.32	.0055	.0114	.0039	.15	1.3
Colrain, . . .	McClellan Reservoir, . .	.03	7.05	.0042	.0100	.0008	.09	4.3
Concord, . .	Nagog Pond, ...	.03	2.71	.0019	.0147	.0018	.40	0.9
Dalton, . . .	Egypt Brook Reservoir, . .	.20	2.80	.0031	.0115	.0013	.09	1.2
	Cady Brook, ...	.21	4.38	.0013	.0101	.0008	.10	2.3
Danvers, . .	Middleton Pond, ...	.47	4.56	.0023	.0240	.0030	.43	1.7
Deerfield (South), .	Roaring Brook, ...	.14	7.60	.0013	.0042	.0002	.22	4.1
Egremont (South),	Goodale Brook, ...	.02	4.67	.0005	.0041	.0003	.13	2.5
Fall River, . .	North Watuppa Lake, . .	.14	4.05	.0030	.0192	.0030	.62	1.0
Falmouth, . .	Long Pond, ...	.02	3.73	.0018	.0117	.0015	1.05	0.4
Fitchburg, . .	Meetinghouse Pond, . . .	.06	3.32	.0059	.0161	.0026	.19	1.0
	Scott Reservoir, ...	.12	3.14	.0063	.0148	.0032	.22	0.9
	Wachusett Lake, ...	.11	2.81	.0049	.0138	.0015	.20	1.0
	Falulah Brook, ...	.24	3.31	.0066	.0229	.0045	.22	0.8
Gardner, . .	Crystal Lake, ...	.10	5.12	.0025	.0143	.0031	.32	2.1

Averages of Chemical Analyses of Surface-water Sources, etc. — Continued.

[Parts in 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Suspended.	Chlorine.	Hardness.
Gloucester,	Dike's Brook Reservoir,	.35	3.72	.0055	.0171	.0021	.81	0.6
	Wallace Reservoir,	.59	4.81	.0045	.0252	.0068	.95	0.5
	Haskell Brook Reservoir,	.24	3.88	.0020	.0147	.0035	.82	0.5
Great Barrington,	East Mountain Reservoir,	.13	5.82	.0026	.0109	.0018	.12	4.1
	Green River,	.00	10.84	.0007	.0043	.0005	.14	9.1
Great Barrington (Housatonic).	Long Pond,	.10	9.95	.0056	.0222	.0023	.16	6.9
Greenfield,	Glen Brook Lower Reservoir,	.01	5.53	.0032	.0067	.0011	.15	3.0
Hatfield,	Running Gutter Brook Reservoir,	.08	5.65	.0014	.0058	.0007	.23	2.5
Haverhill,	Johnson's Pond,	.17	4.94	.0019	.0184	.0013	.51	2.4
	Crystal Lake,	.19	4.87	.0044	.0278	.0080	.43	1.8
	Kenoza Lake,	.21	5.54	.0025	.0244	.0045	.46	2.4
	Lake Saltonstall,	.16	6.56	.0074	.0213	.0042	.65	2.9
	Lake Pentucket,	.16	5.38	.0038	.0251	.0060	.58	2.3
	Millvale Reservoir,	.48	6.23	.0034	.0251	.0053	.41	2.3
Hingham,	Accord Pond,	.22	3.42	.0025	.0169	.0016	.60	0.5
Hinsdale,	Reservoir,	.19	2.32	.0021	.0144	–	.13	0.7
Holyoke,	Whiting Street Reservoir,	.09	4.84	.0056	.0154	.0030	.23	2.6
	Fomer Reservoir,	.35	4.21	.0043	.0147	.0030	.17	1.5
	Wright and Ashley Pond,	.15	4.98	.0067	.0180	.0026	.19	2.6
	High Service Reservoir,	.15	3.95	.0064	.0169	.0023	.20	1.6
	White Reservoir,	.26	3.76	.0069	.0213	.0049	.16	1.6
Hudson,	Gates Pond,	.08	3.35	.0033	.0158	.0018	.28	1.6
Ipswich,	Dow's Brook Reservoir,	.29	5.77	.0033	.0219	.0025	.76	1.9
Lawrence,	Merrimack River, filtered,	.34	6.24	.0071	.0095	–	.50	1.3
Lee,	Codding Brook Upper Reservoir,	.11	5.70	.0085	.0117	.0025	.14	2.1
	Codding Brook Lower Reservoir,	.13	4.52	.0013	.0099	.0013	.13	3.1
	Basin Pond Brook,	.58	5.00	.0018	.0180	.0022	.10	1.5
Lenox,	Reservoir,	.08	7.32	.0017	.0078	.0014	.14	5.5
Leominster,	Morse Reservoir,	.22	3.13	.0069	.0226	.0039	.22	0.5
	Haynes Reservoir,	.38	3.27	.0250	.0380	.0122	.21	0.6
	Fall Brook Reservoir,	.13	2.69	.0029	.0147	.0017	.21	0.7
Lincoln,	Sandy Pond,	.12	3.38	.0090	.0204	.0055	.42	1.3
Longmeadow,	Cooley Brook,	.13	5.64	.0026	.0096	.0023	.27	2.6
Lynn,	Birch Reservoir,	.22	4.65	.0094	.0207	.0027	.69	1.7

Averages of Chemical Analyses of Surface-water Sources, etc. — Continued.

[Parts in 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Suspended.	Chlorine.	Hardness.
Lynn — *Con.*,	Breed's Reservoir,	.41	5.24	.0152	.0317	.0057	.69	2.0
	Walden Reservoir,	.53	6.08	.0066	.0255	.0041	.77	2.1
	Hawkes Reservoir,	.63	7.15	.0102	.0338	.0060	.90	2.8
Manchester,	Gravel Pond,	.11	4.42	.0134	.0139	.0027	.86	1.2
Marlborough,	Lake Williams,	.14	4.95	.0026	.0211	.0025	.60	1.9
	Millham Brook Reservoir,	.43	5,16	.0055	.0239	.0041	.46	1.6
Maynard,	White Pond,	.42	3.87	.0012	.0140	.0017	.32	1.1
Milford,	Charles River, filtered,	.20	6.37	.0011	.0069	-	.37	2.7
Montague,	Lake Pleasant,	.06	2.53	.0019	.0099	.0014	.18	0.8
Nantucket,	Wannacomet Pond,	.12	7.17	.0013	.0194	.0061	2.30	1.5
New Bedford,	Little Quittacas Pond,	.33	3.59	.0033	.0212	.0023	.58	1.0
	Great Quittacas Pond,	.42	4.04	.0023	.0205	.0026	.59	1.0
North Adams,	Notch Brook Reservoir,	.06	8.05	.0024	.0072	.0016	.10	6.2
	Beaman Reservoir,	.06	7.59	.0044	.0100	.0016	.09	4.5
Northampton,	Middle Reservoir,	.22	4.51	.0026	.0137	.0024	.18	1.8
	Mountain Street Reservoir,	.09	4.32	.0019	.0100	.0021	.12	2.0
North Andover,	Great Pond,	.14	4.64	.0032	.0219	.0032	.50	2.0
Northborough,	Lower Reservoir,	.85	5.02	.0082	.0311	.0087	.37	1.5
Northbridge,	Cook Allen Reservoir,	.00	2.98	.0007	.0042	.0006	.22	0.8
North Brookfield,	Doane Pond,	.42	3.73	.0059	.0382	.0122	.20	1.1
	North Pond,	.48	3.53	.0051	.0522	.0225	.22	0.9
Northfield,	Reservoir,	.18	3.73	.0009	.0073	.0003	.15	1.4
Orange,	Reservoir,	.12	3.48	.0024	.0080	.0005	.12	1.2
Palmer,	Lower Reservoir,	.18	4.09	.0061	.0153	.0050	.18	1.2
Peabody,	Spring Pond,	.32	6.97	.0108	.0246	.0069	.87	2.6
	Suntaug Lake,	.06	5.87	.0070	.0220	.0046	1.23	2.8
Pittsfield,	Ashley Brook,	.18	5.85	.0054	.0173	.0024	.12	3.9
	Hathaway Brook,	.05	9.55	.0024	.0089	.0013	.14	6.9
	Mill Brook,	.48	5.23	.0026	.0202	.0032	.14	2.4
	Sacket Brook,	.08	7.64	.0024	.0080	.0011	.14	5.8
	Farnham Reservoir,	.52	5.02	.0040	.0223	.0027	.14	1.9
Plymouth,	Little South Pond,	.05	3.21	.0017	.0192	.0031	.69	0.3
	Great South Pond,	.04	3.23	.0034	.0193	.0023	.69	0.3
Randolph,	Great Pond,	.41	4.42	.0025	.0159	.0030	.59	0.8

Averages of Chemical Analyses of Surface-water Sources, etc. — Concluded.

[Parts in 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Suspended.	Chlorine.	Hardness.
Rockport,	Cape Pond,	.54	11.55	.0147	.0407	.0135	4.15	2.2
Russell,	Black Brook,	.18	4.32	.0008	.0122	.0028	.17	1.7
Rutland,	Muschopauge Lake,	.07	2.76	.0028	.0181	.0066	.32	1.1
Salem,	Wenham Lake,	.37	7.21	.0121	.0252	.0050	.92	2.2
	Longham Reservoir,	1.29	7.84	.0250	.0501	.0143	1.00	1.8
Shelburne,	Fox Brook,	.07	5.85	.0009	.0051	.0004	.12	3.6
Southbridge,	Hatchet Brook Reservoir No. 3,	.18	3.21	.0038	.0169	.0024	.20	1.0
	Hatchet Brook Reservoir No. 4,	.22	2.84	.0044	.0218	.0028	.21	0.9
South Hadley,	Leaping Well Reservoir,	.08	3.07	.0093	.0169	.0061	.18	1.0
	Buttery Brook Reservoir,	.11	4.50	.0086	.0123	.0025	.33	1.1
Spencer,	Shaw Pond,	.09	2.65	.0023	.0153	.0010	.23	1.1
Springfield,	Westfield Little River, filtered,	.20	3.72	.0014	.0082	–	.16	1.4
Stockbridge,	Lake Averic,	.12	7.42	.0015	.0173	.0024	.10	4.9
Stoughton,	Muddy Pond Brook,	.22	3.08	.0013	.0125	.0033	.39	0.9
Taunton,	Assawompsett Pond,	.22	3.83	.0045	.0180	.0041	.52	0.8
	Elder's Pond,	.14	3.86	.0032	.0173	.0021	.51	0.9
Wakefield,	Crystal Lake,	.21	6.48	.0114	.0273	.0034	.83	2.0
Wareham (Onset),	Jonathan Pond,	.03	2.84	.0010	.0094	.0012	.69	0.5
Wayland,	Snake Brook Reservoir,	.76	4.63	.0093	.0432	.0065	.35	1.3
Westfield,	Montgomery Reservoir,	.34	3.59	.0042	.0159	.0016	.14	1.1
	Tillotson Brook Reservoir,	.16	3.20	.0052	.0105	.0025	.16	1.1
West Springfield,	Bear Hole Brook, filtered,	.02	9.40	.0022	.0045	–	.19	3.6
Weymouth,	Great Pond,	1.04	4.02	.0032	.0216	.0030	.47	0.6
Williamsburg,	Reservoir,	.12	4.80	.0006	.0076	.0000	.12	2.0
Williamstown,	Reservoirs,	.04	8.35	.0011	.0061	.0008	.11	5.9
Winchester,	North Reservoir,	.12	3.79	.0041	.0164	.0032	.44	1.5
	South Reservoir,	.09	3.77	.0034	.0161	.0041	.39	1.4
	Middle Reservoir,	.17	3.61	.0046	.0223	.0037	.45	1.5
Worcester,	Bottomly Reservoir,	.24	3.85	.0065	.0172	.0023	.23	1.6
	Kent Reservoir,	.19	3.22	.0036	.0159	.0025	.24	1.5
	Leicester Reservoir,	.15	3.37	.0061	.0157	.0021	.21	1.2
	Mann Reservoir,	.16	3.72	.0025	.0137	.0015	.24	1.4
	Upper Holden Reservoir,	.14	3.83	.0036	.0129	.0018	.23	1.1
	Lower Holden Reservoir,	.13	2.90	.0045	.0118	.0014	.20	1.2

Averages of Chemical Analyses of Ground-water Sources for the Year 1918.

[Parts in 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as —		Hardness.	Iron.
				Free.	Albu-minoid.		Nitrates.	Nitrites.		
Acton,	Tubular wells,	.00	9.13	.0007	.0027	.70	.1433	.0000	3.6	.007
Amesbury,	Tubular wells,	.15	15.02	.0019	.0044	.56	-	-	8.0	.103
Ashland,	Tubular wells,	.00	4.55	.0007	.0021	.43	-	-	1.5	.008
Attleboro,	Large well,	.08	5.18	.0005	.0058	.62	.0120	.0000	1.8	.009
Avon,	Wells,	.00	6.54	.0019	.0045	.57	.1667	.0000	2.1	.006
Ayer,	Large well,	.01	6.20	.0004	.0047	.62	.0560	.0000	2.9	.014
	Tubular wells,	.04	6.73	.0001	.0030	.35	.0160	.0003	2.8	.019
Barnstable,	Tubular wells,	.00	4.30	.0005	.0025	1.15	-	-	0.5	.016
Bedford,	Large well,	.08	4.04	.0012	.0028	.35	-	-	1.6	.023
Billerica,	Tubular wells,	.21	7.58	.0022	.0065	.46	-	-	2.9	.172
Braintree,	Filter-gallery,	.55	6.40	.0033	.0211	.91	.0167	.0000	1.9	.062
Bridgewater,	Wells,	.00	5.13	.0005	.0022	.65	.0316	.0000	1.7	.016
Brookfield (East),	Tubular wells,	.00	3.63	.0007	.0019	.22	-	-	0.7	.005
Brookline,	Tubular wells and filter-gallery, filtered.	.16	9.55	.0009	.0079	.79	.0335	.0000	4.1	.011
Chelmsford (North),	Tubular wells,	.13	5.45	.0156	.0100	.47	.0380	.0001	1.9	.013
Chelmsford (Center),	Tubular wells,	.00	8.86	.0004	.0016	.72	.1660	.0001	2.9	.007
Chicopee (Fairview),	Tubular wells,	.08	5.92	.0007	.0022	.23	.0687	.0005	1.7	.044
Cohasset,	Tubular wells No. 2,	.03	14.62	.0010	.0052	2.01	.1830	.0000	5.6	.013
	Filtered water,	.16	8.17	.0020	.0107	1.22	.0062	.0001	2.7	.027
Dedham,	Large well and tubular wells.	.08	9.61	.0022	.0062	1.05	.1280	.0001	4.0	.008
Deerfield (Fire District).	Wells,	.00	6.77	.0005	.0049	.14	-	-	3.0	.01[illegible]
Douglas,	Tubular wells,	.00	4.33	.0009	.0019	.40	.0553	.0000	1.8	.066
Dracut (Water Supply District).	Tubular wells,	.00	8.27	.0003	.0013	.56	.0997	.0000	3.6	.007
Dracut (Collinsville).	Tubular wells,	.05	6.77	.0006	.0059	.34	.0247	.0000	2.6	.008
Dudley,	Tubular wells,	.00	3.53	.0003	.0023	.27	-	-	1.1	.004
Duxbury,	Tubular wells,	.00	4.70	.0007	.0027	.85	-	-	0.6	.006
Easthampton,	Tubular wells,	.00	6.40	.0003	.0017	.16	.0260	.0000	3.8	.008
Easton,	Well,	.00	5.18	.0005	.0033	.55	.0524	.0000	1.7	.010
Edgartown,	Large well,	.00	3.07	.0003	.0027	.96	-	-	0.2	.005
Fairhaven,	Tubular wells,	.42	7.70	.0016	.0115	1.09	.0263	.0000	2.3	.013
Foxborough,	Tubular wells,	.01	5.07	.0005	.0016	.51	.0460	.0000	1.6	.014
Framingham,	Filter-gallery,	.04	11.53	.0165	.0076	1.83	.0176	.0003	4.8	.010
Franklin,	Tubular wells,	.00	5.18	.0006	.0028	.60	.0410	.0000	1.7	.007
Grafton,	Filter-gallery,	.03	10.97	.0005	.0036	1.56	.1200	.0000	4.1	.068

Averages of Chemical Analyses of Ground-water Sources, etc. — Continued.

[Parts in 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as —		Hardness.	Iron.
				Free.	Albu-minoid.		Nitrates.	Nitrites.		
Granville, . .	Well, ...	.02	4.17	.0003	.0031	.29	-	-	1.5	.015
Groton, . . .	Large well, ...	.00	7.30	.0009	.0025	.24	.0000	.0000	3.5	.014
Groton (West Groton Water Supply District).	Tubular wells, ...	.00	4.42	.0003	.0023	.20	-	-	2.8	.012
Hingham, . .	Wells, ...	.36	6.43	.0171	.0129	.81	-	-	1.9	.028
Holliston, . .	Large well, ...	.50	5.85	.0057	.0197	.44	.0060	.0000	1.6	.072
Hopkinton, . .	Tubular wells, ...	.00	12.27	.0023	.0042	1.11	.3100	.0001	5.0	.015
Kingston, . .	Tubular wells, ...	.00	4.43	.0009	.0031	.74	-	-	1.0	.004
Leicester, . .	Wells, ...	.11	6.17	.0005	.0045	.34	.0733	.0030	2.1	.013
Leicester (Cherry Valley and Rochdale Water Supply District).	Wells, ...	.11	5.47	.0086	.0067	.33	-	-	2.4	.009
Littleton, . .	Tubular wells, ...	.00	4.53	.0005	.0014	.24	.0250	.0000	1.8	.008
Lowell, . . .	Boulevard wells (tubular),	.56	7.62	.0480	.0081	.46	.0263	.0001	2.8	.344
Manchester, . .	Wells, ...	.01	13.23	.0004	.0023	2.05	.1733	.0000	3.9	.017
Mansfield, . .	Large well, ...	.00	5.17	.0005	.0026	.47	.0460	.0000	1.6	.006
Marion, . . .	Tubular wells, ...	.00	4.42	.0004	.0017	.67	.0250	.0000	1.0	.009
Mattapoisett, . .	Tubular wells, ...	.00	6.52	.0006	.0027	.86	.0343	.0000	2.4	.004
Medfield, . .	Spring, ...	.00	3.80	.0007	.0033	.33	.0053	.0000	1.2	.012
Medway, . . .	Tubular wells, ...	.00	6.10	.0009	.0027	.62	.0310	.0002	2.4	.005
Merrimac, . .	Tubular wells, ...	.00	6.87	.0006	.0023	.53	.0247	.0000	2.8	.010
Methuen, . .	Tubular wells, ...	.32	6.99	.0044	.0114	.48	.0216	.0000	3.0	.054
Middleborough, .	Well, ...	.55	7.33	.0090	.0094	.65	.0305	.0000	2.3	.355
	Filtered water, . . .	.13	6.18	.0005	.0059	.65	.0260	.0000	2.3	.019
Millbury, . .	Well, ...	.01	4.60	.0008	.0041	.36	.0210	.0000	1.6	.006
Millis, . . .	Spring, ...	.00	10.80	.0005	.0023	.81	.2600	.0000	4.4	.007
Monson, . . .	Large well, ...	.08	3.66	.0008	.0042	.22	-	-	0.9	.006
Natick, . . .	Large well, ...	.00	9.23	.0011	.0046	.83	.0273	.0000	4.4	.007
Needham, . .	Wells, ...	.01	6.72	.0006	.0031	.74	.1167	.0000	2.5	.016
	Hicks Spring, ...	.00	7.25	.0010	.0030	.78	.1875	.0000	2.4	.006
Newburyport, .	Wells and Artichoke River, filtered.	.20	7.42	.0062	.0136	.81	.0205	.0000	2.8	.046
Newton, . . .	Tubular wells and filter-gallery.	.01	6.60	.0007	.0041	.51	.0478	.0001	2.7	.007
No. Attleborough, .	Wells, ...	.04	6.77	.0015	.0043	.49	.0260	.0000	2.1	.014
Norton, . . .	Tubular wells, ...	.00	4.35	.0002	.0017	.39	-	-	1.4	.014
Norwood, . .	Tubular wells, ...	.14	9.20	.0024	.0059	.60	.0371	.0000	3.7	.033
Oak Bluffs, . .	Springs, ...	.00	4.65	.0013	.0027	.99	.0100	.0000	0.5	.010

Averages of Chemical Analyses of Ground-water Sources, etc. — Concluded.

[Parts in 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as —		Hardness.	Iron.
				Free.	Albuminoid.		Nitrates.	Nitrites.		
Oxford,	Tubular wells,	.00	5.25	.0006	.0028	.35	.0580	.0000	1.8	.002
Palmer (Bondsville),	Tubular wells,	.00	5.70	.0008	.0023	.23	.0213	.0000	2.1	.010
Pepperell,	Tubular wells,	.00	3.00	.0006	.0021	.21	-	-	1.4	.005
Plainville,	Tubular wells,	.00	5.15	.0013	.0022	.42	-	-	2.2	.020
Provincetown,	Tubular wells in Truro,	.00	35.30	.0004	.0019	14.04	-	-	8.1	.021
Reading,	Filter-gallery,	.58	9.97	.0171	.0164	1.36	.0122	.0001	2.9	.350
	Filtered water,	.20	17.20	.0011	.0097	1.08	.0132	.0097	7.7	.050
Salisbury,	Well,	.22	8.30	.0007	.0058	.60	-	-	3.5	.020
Scituate,	Tubular wells,	.00	15.63	.0007	.0026	3.33	.2063	.0000	5.6	.006
Sharon,	Well,	.04	14.60	.0004	.0029	1.80	.2667	.0000	5.8	.009
	Tubular wells,	.00	5.67	.0010	.0027	.52	.0390	.0000	2.2	.004
Sheffield,	Spring,	.00	4.30	.0060	.0028	.10	.0080	.0000	1.6	.005
Shirley,	Well,	.00	4.47	.0008	.0019	.45	.1250	.0000	1.4	.010
Shrewsbury,	Wells,	.00	3.60	.0007	.0035	.37	.0230	.0000	1.6	.006
South Hadley (Fire District No. 2).	Large well,	.02	4.90	.0006	.0024	.17	.0327	.0000	2.1	.011
Tisbury,	Well,	.00	4.12	.0003	.0031	.96	.0050	.0000	0.5	.011
Uxbridge,	Tubular wells,	.00	6.10	.0003	.0018	.55	.0400	.0000	1.8	.006
Walpole,	Tubular wells,	.00	4.10	.0005	.0022	.49	.0425	.0000	1.7	.009
Waltham,	Old well,	.17	8.63	.0046	.0040	.83	.0181	.0000	3.6	.075
	New well,	.00	8.38	.0013	.0035	.65	.0207	.0000	3.6	.005
Ware,	Wells,	.00	7.52	.0006	.0022	.51	.1600	.0001	2.6	.011
Wareham (Fire District).	Tubular wells,	.00	3.05	.0005	.0030	.59	-	-	0.6	.014
Warren (West),	Large well,	.00	5.27	.0003	.0014	.20	-	-	2.0	.004
Webster,	Wells,	.05	3.60	.0007	.0074	.36	.0120	.0000	1.3	.007
Wellesley,	Tubular wells,	.00	9.55	.0007	.0026	1.15	.0693	.0000	4.0	.013
	Well at Williams Spring,	.00	15.25	.0007	.0030	1.19	.5500	.0000	5.0	.007
	Filter-gallery,	.00	9.32	.0009	.0036	1.03	.0872	.0000	3.9	.003
Westborough,	Filter basin,	.05	3.69	.0013	.0096	.29	-	-	1.3	.017
West Brookfield,	Tubular wells,	.00	4.43	.0003	.0017	.30	.0583	.0000	1.4	.007
Westford,	Tubular wells,	.00	4.60	.0000	.0024	.18	-	-	1.7	.002
Weston,	Well,	.28	7.42	.0017	.0103	.60	.0383	.0000	2.7	.008
Winchendon,	Wells,	.08	3.66	.0023	.0043	.17	-	-	1.0	.144
Woburn,	Filter-gallery,	.01	12.04	.0019	.0073	1.48	.0328	.0001	5.0	.005
Worthington,	Springs,	.09	4.00	.0007	.0049	.13	-	-	1.8	.074
Wrentham,	Tubular wells,	.00	4.45	.0008	.0030	.40	.0480	.0000	1.6	.009

WATER SUPPLY STATISTICS.

In the year 1918 a water supply was introduced in the small town of Dunstable, which had a population of 362 by the census of 1915. There was very little other water works construction during the year. Of the 354 cities and towns in Massachusetts, 213, including all of the 37 cities and 176 of the towns, are provided with public water supplies. The following table gives a classification by population (census of 1915) of the cities and towns having and not having public water supplies at the end of the year: —

POPULATION, 1915.	Number of Places of Given Population having Public Water Supplies.	Total Population of Places in Preceding Column.	Number of Places of Given Population not having Public Water Supplies.	Total Population of Places in Preceding Column.
Under 500,	1	362	39	12,908
500-999,	7	5,229	36	27,536
1,000-1,499,	21	27,759	24	29,589
1,500-1,999,	12	21,685	20	33,947
2,000-2,499,	17	37,819	10	22,002
2,500-2,999,	20	54,895	6	16,013
3,000-3,499,	6	19,928	3	9,920
3,500-3,999,	8	30,123	-	-
Above 4,000,	121	3,329,981	3	13,614
Totals,	213	3,527,781	141	165,529

The 213 cities and towns having public water supplies are classified in the following table according to the dates when a fairly complete system of water supply was first introduced: —

YEARS.	Number of Public Water Supplies introduced.	YEARS.	Number of Public Water Supplies introduced.
Previous to 1850,	5	1890-1899, inclusive,	34
1850-1859, inclusive,	4	1900-1909, inclusive,	21
1860-1869, inclusive,	9	1910-1918, inclusive,	25
1870-1879, inclusive,	45	Total,	213
1880-1889, inclusive,	70		

The first table presented shows that although but 60 per cent of the cities and towns in the State are provided with public water supplies,

the total population of the places supplied is 96 per cent of the total population of the State. The populations given in this table were obtained by using the total population of the cities and towns supplied, and is somewhat greater than the actual number of persons to whom the public water supply is available, but the difference is not great. With the exception of the town of Tewksbury, all of the towns in the State having a population in excess of 5,000 are now supplied with water; and there are only 12 towns having a population in excess of 2,500 which are not provided with public water supplies. These towns are as follows: —

Town.	Population.	Town.	Population.
Tewksbury,	5,265	Sutton,	2,829
Warren,	4,268	Seekonk,	2,767
Templeton,	4,081	Bourne,	2,672
Somerset,	3,377	Hanover,	2,666
Auburn,	3,281	Swansea,	2,558
Westport,	3,262	Wilbraham,	2,521

At the present time the water works are owned either by the municipality or by a water, water supply or fire district in all of the cities and 133 of the towns, while in 43 towns the works are owned by private companies. The following table gives the classification by population of the cities and towns which own their water works and those which are supplied with water by private companies: —

Population, 1915.	Cities and Towns owning Water Works.		Cities and Towns supplied with Water by Private Companies.	
	Number.	Total Population.	Number.	Total Population.
Under 1,000,	4	2,263	4	3,328
1,000-1,999,	23	33,846	10	15,598
2,000-2,999,	28	69,407	9	23,307
3,000-3,999,	8	28,942	6	21,109
4,000-4,999,	7	31,251	2	9,476
5,000-5,999,	16	88,166	3	16,117
6,000-6,999,	10	66,316	3	18,778
7,000-7,999,	7	52,937	-	-
Over 8,000,	67	2,979,893	6	67,047
Total,	170	3,353,021	43	174,760

The tendency toward municipal ownership of water works is shown in the following table, giving, for the census years since 1890, the total population of all cities and towns supplied with water, and the total population of those supplied by private companies with its percentage of the total population of all places supplied: —

Year.	Total Population of All Cities and Towns provided with Public Water Supplies.	Population of Towns supplied by Private Companies.	Per Cent of Total Population supplied with Water.
1890,	1,924,812	318,319	16.5
1895,	2,237,017	212,579	9.5
1900,	2,565,301	236,869	9.2
1905,	2,792,490	193,290	6.9
1910,	3,171,055	159,730	5.0
1915,	3,528,769	174,760	5.0

The foregoing table shows that the total population of the towns supplied with water by private companies is only 5 per cent of the total population of all the cities and towns supplied with water. There are only 12 towns having a population in excess of 5,000 which are supplied by private companies. These towns are as follows: —

Town.	Population, 1915.	Town.	Population, 1915.
Southbridge,	14,217	Fairhaven,	6,277
Milford,	13,684	Ludlow,	6,251
Dedham,	11,043	Grafton,	6,250
Palmer,	9,468	Amherst,	5,558
Bridgewater,	9,381	Millbury,	5,295
Northbridge,	9,254	Hingham,	5,264

In the annual report of the State Department of Health for the year 1915 (pages 296 to 306) a table will be found showing the population and valuation of all of the cities and towns in Massachusetts in 1915, together with certain other information relative to the ownership of the water works and the date of their introduction into those places so provided.

CONSUMPTION OF WATER.

Records of the consumption of water are kept in nearly all of the cities and towns where water is pumped, while in several places supplied by gravity venturi meters have been installed to measure the consumption.

The winter of 1917–18 was far more severe than any experienced in Massachusetts since the general introduction of water supplies was begun, and a great many service pipes and even supply mains became frozen. After the first severe cold in December, 1917, faucets were generally allowed to run continuously in many places, often at the suggestion of the water departments, and quantities of water far in excess of the ordinary consumption were used by most of the cities and towns. Under these conditions reservoirs became depleted, and there were serious shortages of water in many places. It is also notable that in many cities and towns the water consumption in the spring months was much greater than in the same months of the previous year, the increases ranging as high as 25 per cent. This increase is probably due largely to leakage caused by the freezing of pipes. With the limited resources of the water departments due to the war, it has not been practicable in many places to make the repairs and improvements required to reduce the consumption to the normal amount.

The following table gives statistics with regard to the consumption of water in the year 1918 in those cities and towns from which records could be obtained. The populations given in the table were obtained by adding three-fifths of the increase in population between 1910 and 1915 to the population as determined by the census of the latter year. The daily consumption of water per inhabitant has been obtained by dividing the average daily consumption by the estimated total population of the city or town in 1918. The quantity obtained in this manner is somewhat less than the actual consumption per person using the water, because there are in all cities and towns a greater or less number of persons who do not use the public supply. The difference between the number of inhabitants and the number of consumers would account, to a large extent, for the low rate per inhabitant in some of the towns which contain villages to which the public water supply has not been extended, and in towns where the works have been in operation but a short time, and in which, in consequence, water has not come into general use. In certain of the towns the population during the summer months is much greater than is shown by the census returns, and in such cases the consumption per inhabitant as given in the table is higher than it would be if allowance were made for the increased population in the summer. With a few exceptions, however, the difference between the census returns and the actual population supplied is not great.

Consumption of Water in Various Cities and Towns in 1918.

City or Town.	Estimated Population.	Average Daily Consumption.	
		Gallons.	Gallons per Inhabitant.
Metropolitan Water District: —	1,241,460	129,764,000	105
Arlington,	17,110	1,290,300	75
Belmont,	9,604	577,700	60
Boston,	781,047	94,634,000	121
Chelsea,	50,010	3,501,200	70
Everett,	40,258	3,365,800	84
Lexington,	5,910	494,600	84
Malden,	51,609	3,254,700	63
Medford,	34,924	2,161,200	62
Melrose,	17,579	1,180,600	67
Milton,	9,006	434,500	48
Nahant,	1,509	228,200	151
Quincy,	45,493	4,632,100	102
Revere,	29,353	1,975,500	67
Somerville,	92,625	7,433,200	80
Stoneham,	7,728	617,700	80
Swampscott,	8,030	606,100	76
Watertown,	18,699	2,434,700	130
Winthrop,	14,334	941,900	66
Agawam,	5,187	128,000	25
Amesbury,	7,732	775,000	100
Andover,	8,384	655,000	78
Ashland,	2,199	81,000	37
Athol,	10,531	907,000	86
Attleboro,	19,839	1,435,000	72
Avon,	2,255	104,000	46
Barnstable,	5,186	167,000	32
Bedford,	1,445	47,000	33
Beverly,	25,544	1,909,000	75
Billerica,	3,520	397,000	113
Braintree,	10,109	722,000	71
Bridgewater,	10,397	256,000	25
Brockton,	65,534	2,985,000	46
Brookline,	36,909	3,144,000	85
Cambridge,	111,212	11,127,000	100
Canton,	6,119	393,000	64
Chelmsford,	5,285	132,000	25
Clinton,	13,262	726,000	55
Concord,	6,837	623,000	91
Danvers and Middleton.	13,654	1,760,000	129
Dedham,	12,098	1,133,000	94
Dudley,	4,437	181,000	41
Duxbury,	2,061	78,000	38
East Longmeadow,	2,171	27,000	12
Easthampton,	10,638	767,000	72
Easton,	5,019	179,000	36
Fairhaven,	6,970	330,000	47
Fall River,	128,089	6,344,000	50
Falmouth,	4,381	420,000	96
Fitchburg,	40,754	4,396,000	108
Framingham,	17,607	1,174,000	67
Franklin,	6,919	439,000	63
Gloucester,	24,526	1,696,000	69
Greenfield,	13,933	1,505,000	108
Groton,	2,440	110,000	45
Holliston,	2,834	109,000	38
Holyoke,	62,668	7,200,000	115
Hudson,	6,767	450,000	66
Ipswich,	6,569	377,000	57
Lancaster,	2,658	81,000	31
Lawrence,	92,879	4,475,000	43
Lenox,	3,351	300,000	90
Lincoln,	1,391	294,000	212
Littleton,	1,228	53,000	43
Longmeadow,	2,201	91,000	41
Lowell,	126,000	7,544,000	60
Lynn and Saugus,	111,217	8,374,000	75
Manchester,	3,108	324,000	104
Mansfield,	6,125	764,000	125
Marblehead,	7,767	621,000	80

Consumption of Water in Various Cities and Towns in 1918 — Concluded.

City or Town.	Estimated Population.	Average Daily Consumption. Gallons.	Gallons per Inhabitant.	City or Town.	Estimated Population.	Average Daily Consumption. Gallons.	Gallons per Inhabitant.
Marion,	1,503	92,000	61	Randolph and Holbrook.	8,021	527,000	66
MARLBOROUGH,	15,653	659,000	42	Reading,	7,397	279,000	38
Mattapoisett,	1,423	79,000	56	Rockport,	4,435	268,000	60
Maynard,	6,998	366,000	52	SALEM,	47,000	4,995,000	106
Merrimac,	2,040	123,000	60	Salisbury,	1,752	115,000	66
METHUEN,	15,542	952,000	61	Sharon,	2,563	215,000	84
Middleborough,	8,881	444,000	50	Shirley,	2,318	81,000	35
Milford and Hopedale.	17,009	807,000	48	Shrewsbury,	3,303	75,000	23
Millbury,	5,628	286,000	51	Southbridge,	15,192	1,016,000	67
Millis,	1,468	50,700	35	SPRINGFIELD,	111,398	12,970,000	116
Montague and Erving.	9,740	790,000	81	TAUNTON,	37,302	3,154,000	85
Nantucket,	3,288	249,000	76	Tisbury,	1,401	148,000	106
Natick,	11,871	742,000	63	Wakefield,	13,607	786,000	58
Needham,	7,452	462,000	62	Walpole,	5,849	1,209,000	207
NEW BEDFORD,	117,318	9,716,000	83	WALTHAM,	31,546	2,510,000	80
NEWBURYPORT,	15,528	1,380,000	89	Wareham,	5,820	176,000	30
NEWTON,	45,097	3,426,000	76	Webster,	13,199	788,000	60
North Andover,	6,212	402,000	65	Wellesley,	7,056	545,000	78
North Attleborough,	9,300	475,000	51	West Brookfield,	1,265	37,000	29
Norton,	2,613	173,000	66	Westfield,	19,831	2,331,000	118
Norwood,	12,755	1,532,000	120	Westford,	2,838	167,000	59
Oak Bluffs,	1,342	186,000	139	Weston,	2,484	149,000	60
Orange,	5,437	161,000	30	Weymouth,	14,613	1,445,000	99
PEABODY,	20,367	3,533,000	173	Whitman,	7,657	256,000	33
Pepperell,	2,771	143,000	52	WOBURN,	17,071	2,320,000	136
PITTSFIELD,	44,099	5,683,000	129	WORCESTER,	172,724	15,719,000	91
Plainville,	1,422	45,000	32	Wrentham,	2,817	145,000	51
Plymouth,	13,397	1,563,000	117				

RAINFALL.

The normal yearly rainfall in Massachusetts as deduced from long-continued observations in various parts of the State is 44.46 inches. The average rainfall for the year 1918 in these places was 37.68 inches, a deficiency of 6.78 inches. The year was the fifteenth in succession in

which the rainfall has been less than the normal, the accumulated deficiency at the end of the year being 59.08 inches, or 14.62 inches more than the total rainfall in a normal year. The rainfall in January was normal, there was an excess of precipitation in the months of June and September, and a deficiency in the other nine months of the year. The greatest excess in any month occurred in September, when the average rainfall was 7.28 inches, or 3.82 inches greater than the normal, and the greatest deficiency occurred in October, when the average rainfall was 1.03 inches, or 2.77 inches less than the normal.

The following table gives the normal rainfall in the State for each month as deduced from observations at various places for a long period of years, together with the average rainfall at those places for each month during the year 1918 and the departure from the normal: —

Month.	Normal Rainfall (Inches).	Rainfall in 1918 (Inches).	Excess or Deficiency in 1918 (Inches).	Month.	Normal Rainfall (Inches).	Rainfall in 1918 (Inches).	Excess or Deficiency in 1918 (Inches).
January,	3.73	3.73	—.00	August,	4.22	2.26	—1.96
February,	3.60	2.98	—.62	September,	3.46	7.28	+3.82
March,	3.88	2.61	—1.27	October,	3.80	1.03	—2.77
April,	3.59	3.38	—.21	November,	3.79	2.46	—1.33
May,	3.67	1.88	—1.79	December,	3.67	3.35	—.32
June,	3.25	3.35	+.10	Totals,	44.46	37.68	—6.78
July,	3.80	3.37	—.43				

Flow of Streams.

Sudbury River.

The average flow of the Sudbury River during the year 1918 was 736,000 gallons per day per square mile of drainage area, or about 76 per cent of the normal flow for the past forty-four years. The flow was in excess of the normal in the months of February and September, but less than the normal in the other ten months of the year. The greatest excess occurred in the month of September and the greatest deficiency in the month of January. The average flow for the driest six months, July to December, inclusive, was 269,000 gallons per day per square mile, or 72 per cent of the normal flow for such period during the past forty-four years.

In order to show the relation between the flow of the Sudbury River during each month of the year 1918 and the normal flow of that

stream, as deduced from observations during forty-four years, from 1875 to 1918, inclusive, the following table has been prepared. The drainage area of the Sudbury River above the point of measurement is 75.2 square miles.

Table showing the Average Daily Flow of the Sudbury River for Each Month in the Year 1918, in Cubic Feet per Second per Square Mile of Drainage Area, and in Million Gallons per Day per Square Mile of Drainage Area; also, Departure from the Normal Flow.

Month.	Normal Flow.		Actual Flow in 1918.		Excess or Deficiency.	
	Cubic Feet per Second per Square Mile.	Million Gallons per Day per Square Mile.	Cubic Feet per Second per Square Mile.	Million Gallons per Day per Square Mile.	Cubic Feet per Second per Square Mile.	Million Gallons per Day per Square Mile.
January,	1.784	1.153	.422	.273	−1.362	−.880
February,	2.565	1.658	2.798	1.809	+.233	+.151
March,	4.158	2.688	3.384	2.187	−.774	−.501
April,	3.056	1.976	2.267	1.466	−.789	−.510
May,	1.646	1.064	.989	.639	−.657	−.425
June,	.759	.491	.286	.185	−.473	−.306
July,	.277	.179	.149	.096	−.128	−.083
August,	.365	.236	−.083	−.054	−.448	−.290
September,	.344	.222	.986	.637	+.642	+.415
October,	.634	.410	.424	.274	−.210	−.136
November,	1.117	.722	.756	.489	−.361	−.233
December,	1.462	.945	1.451	.938	−.011	−.007
Average for whole year,	1.508	.975	1.139	.736	−.369	−.239

In the annual report of the State Department of Health for the year 1915 (pages 312 to 318) tables were presented giving the record of the rainfall upon the drainage area of the Sudbury River and the yield expressed in inches in depth upon the drainage area (inches of rainfall collected) for each of the forty-one years from 1875 to 1915, inclusive. The corresponding record for the years 1916, 1917 and 1918, together with the average for the entire period of forty-four years, is given in the following table: —

Rainfall, in Inches, received and collected on the Sudbury River Drainage Area.

Month.	1916.			1917.		
	Rainfall.	Rainfall collected.	Per Cent collected.	Rainfall.	Rainfall collected.	Per Cent collected.
January,	1.53	1.680	109.8	3.50	.909	25.9
February,	5.91	2.262	38.2	2.68	1.216	45.5
March,	4.16	3.245	78.1	4.96	3.940	79.4
April,	4.19	5.243	125.1	2.41	2.425	100.5
May,	3.43	2.567	74.9	4.93	2.632	53.4
June,	4.77	2.068	43.4	4.23	1.802	42.7
July,	5.17	1.044	20.2	1.11	.076	6.8
August,	2.01	.139	6.9	6.40	.361	5.6
September,	1.80	.044	2.5	1.52	.100	6.6
October,	1.49	—.009	—.6	5.65	.860	15.2
November,	2.28	.189	8.3	1.31	.757	57.6
December,	3.22	.562	17.4	2.81	.678	24.2
Totals and averages,	39.96	19.034	47.6	41.51	15.756	38.0

Month.	1918.			Mean for Forty-four Years, 1875-1918.		
	Rainfall.	Rainfall collected.	Per Cent collected.	Rainfall.	Rainfall collected.	Per Cent collected.
January,	3.47	.486	14.0	4.05	2.057	50.9
February,	3.58	2.914	81.3	4.12	2.693	65.4
March,	2.50	3.896	156.2	4.32	4.794	110.9
April,	4.43	2.530	57.1	3.56	3.410	96.8
May,	1.16	1.141	98.8	3.27	1.898	58.0
June,	3.65	.319	8.7	3.10	.847	27.3
July,	4.07	.171	4.2	3.64	.319	8.8
August,	1.61	—.096	—6.0	3.86	.421	10.9
September,	8.60	1.100	12.8	3.37	.384	11.4
October,	1.04	.490	47.0	3.77	.730	19.4
November,	2.75	.843	30.7	3.65	1.247	34.2
December,	3.68	1.673	45.5	3.80	1.686	44.3
Totals and averages,	40.54	15.467	38.2	44.51	20.486	46.0

The following table gives the record of the yield of the drainage area of the Sudbury River for each of the last three years, the flow being

expressed in gallons per day per square mile of drainage area in order to render the table more convenient for use in estimating the probable yield of drainage areas used as sources of water supply: —

Yield of the Sudbury River Drainage Area in Gallons per Day per Square Mile.[1]

Month.	1916.	1917.	1918.	Mean for Forty-four Years, 1875-1918.
January,	942,000	510,000	273,000	1,153,000
February,	1,356,000	755,000	1,809,000	1,658,000
March,	1,820,000	2,209,000	2,187,000	2,688,000
April,	3,037,000	1,405,000	1,466,000	1,976,000
May,	1,439,000	1,476,000	639,000	1,064,000
June,	1,198,000	1,044,000	185,000	491,000
July,	585,000	43,000	96,000	179,000
August,	78,000	202,000	—54,000	236,000
September,	26,000	58,000	637,000	222,000
October,	—5,000	482,000	274,000	410,000
November,	110,000	438,000	489,000	722,000
December,	315,000	380,000	938,000	945,000
Average for whole year,	904,000	750,000	736,000	975,000
Average for driest six months,	186,000	267,000	269,000	375,000

[1] The drainage area of the Sudbury River used in making up these records included water surfaces amounting to about 2 per cent of the whole area, from 1875 to 1878, inclusive, subsequently increasing by the construction of storage reservoirs to about 3 per cent in 1879, to 3.5 per cent in 1885, to 4 per cent in 1894 and to 6.5 per cent in 1898. The drainage area also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

Nashua River.

The average flow of the South Branch of the Nashua River above Clinton during the year 1918 was 902,000 gallons per day per square mile of drainage area, or 85 per cent of the normal flow for the past twenty-two years. The flow was in excess of the normal in the months of February, March and September, and less than the normal in the other nine months of the year. The greatest excess occurred in the month of February and the greatest deficiency in the month of January. The average flow for the driest six months, May to November, inclusive, was 412,000 gallons per day per square mile, or about 79 per cent of the normal flow for such a period during the past twenty-two years.

In order to show the relation between the flow of the Nashua River

during each month of the year 1918 and the normal flow of that stream as deduced from observations during twenty-two years, from 1897 to 1918, inclusive, the following table has been prepared. The drainage area of the Nashua River above the point of measurement was 119 square miles from 1897 to 1907, and 118.19 square miles from 1908 to 1913, inclusive. Since Jan. 1, 1914, the city of Worcester has been diverting water from 9.35 square miles of this drainage area for the supply of that city, leaving the net drainage area 108.84 square miles. In the calculations of yield allowance has been made for water overflowing from the Worcester area.

Table showing the Average Daily Flow of the South Branch of the Nashua River for Each Month in the Year 1918, in Cubic Feet per Second per Square Mile of Drainage Area, and in Million Gallons per Day per Square Mile of Drainage Area; also, Departure from the Normal Flow.

Month.	Normal Flow.		Actual Flow in 1918.		Excess or Deficiency.	
	Cubic Feet per Second per Square Mile.	Million Gallons per Day per Square Mile.	Cubic Feet per Second per Square Mile.	Million Gallons per Day per Square Mile.	Cubic Feet per Second per Square Mile.	Million Gallons per Day per Square Mile.
January,	1.821	1.177	.749	.484	—1.072	—.693
February,	2.190	1.416	3.131	2.024	+.941	+.608
March,	3.945	2.550	4.008	2.590	+.063	+.040
April,	3.272	2.115	2.487	1.608	—.785	—.507
May,	1.824	1.179	1.042	.673	—.782	—.506
June,	1.203	.778	.809	.523	—.394	—.255
July,	.663	.429	.433	.280	—.230	—.149
August,	.644	.416	.246	.159	—.398	—.257
September,	.509	.329	.933	.603	+.424	+.274
October,	.746	.482	.528	.341	—.218	—.141
November,	1.091	.706	.900	.582	—.191	—.124
December,	1.707	1.104	1.634	1.056	—.073	—.048
Average for whole year,	1.632	1.055	1.395	.902	—.237	—.153

In the annual report of the State Department of Health foi the year 1915 (pages 324 to 327) tables were presented giving the record of the rainfall upon the drainage area of the Nashua River and the total yield expressed in inches in depth upon the drainage area (inches of rainfall collected) for each of the nineteen years from 1897 to 1915, inclusive. The corresponding record for the years 1916, 1917 and 1918, together

with the average for the entire period of twenty-two years, is given in the following table: —

Rainfall, in Inches, received and collected on the Nashua River Drainage Area.

Month.	1916.			1917.		
	Rainfall.	Rainfall collected.	Per Cent collected.	Rainfall.	Rainfall collected.	Per Cent collected.
January,	1.60	2.346	146.7	3.37	1.224	36.3
February,	5.98	3.030	50.7	3.05	1.476	48.3
March,	3.32	3.374	101.5	4.21	4.409	104.8
April,	3.65	5.696	156.0	1.80	2.535	140.6
May,	3.34	3.028	90.7	3.89	2.350	60.5
June,	6.57	3.546	53.9	4.47	2.122	47.4
July,	5.66	1.937	34.2	1.22	.471	38.8
August,	1.72	.506	29.5	4.46	.552	12.4
September,	4.21	.506	12.0	1.20	.144	12.0
October,	1.42	.250	17.6	6.03	.990	16.4
November,	3.15	.554	17.6	1.25	.540	43.1
December,	2.81	.820	29.2	2.31	.694	30.0
Totals and averages,	43.43	25.593	58.9	37.26	17.507	47.0

Month.	1918.			Mean for Twenty-two Years, 1897-1918.		
	Rainfall.	Rainfall collected.	Per Cent collected.	Rainfall.	Rainfall collected.	Per Cent collected.
January,	2.97	.864	29.1	3.62	2.100	58.0
February,	4.25	3.260	76.6	3.80	2.296	60.4
March,	2.24	4.614	206.0	4.03	4.549	112.8
April,	3.47	2.775	80.0	3.71	3.651	98.5
May,	1.07	1.201	112.8	3.28	2.103	64.2
June,	4.57	.902	19.8	3.76	1.342	35.7
July,	2.80	.499	17.8	4.04	.765	18.9
August,	2.82	.284	10.1	4.14	.742	17.9
September,	7.18	1.041	14.5	3.59	.567	15.8
October,	1.58	.609	38.6	3.38	.860	25.4
November,	3.08	1.004	32.6	3.27	1.218	37.3
December,	3.74	1.884	50.4	4.06	1.969	48.5
Totals and averages,	39.77	18.937	47.6	44.68	22.162	49.6

The following table gives a record of the yield of the drainage area of the Nashua River for each of the last three years, the flow being expressed in gallons per day per square mile of drainage area: —

Yield of the Nashua River Drainage Area in Gallons per Day per Square Mile.[1]

Month.	1916.	1917.	1918.	Mean for Twenty-two Years, 1897-1918.
January,	1,315,000	686,000	484,000	1,177,000
February,	1,816,000	916,000	2,024,000	1,416,000
March,	1,891,000	2,472,000	2,590,000	2,550,000
April,	3,300,000	1,468,000	1,608,000	2,115,000
May,	1,697,000	1,317,000	673,000	1,179,000
June,	2,054,000	1,229,000	523,000	778,000
July,	1,086,000	264,000	280,000	429,000
August,	284,000	309,000	159,000	416,000
September,	294,000	84,000	603,000	329,000
October,	140,000	555,000	341,000	482,000
November,	321,000	313,000	582,000	706,000
December,	460,000	389,000	1,056,000	1,104,000
Average for whole year,	1,215,000	834,000	902,000	1,055,000
Average for driest six months,	432,000	320,000	412,000	522,000

[1] The drainage area used in making up these records included water surfaces amounting to 2.2 per cent of the whole area from 1897 to 1902, inclusive, to 2.4 per cent in 1903, to 3.6 per cent in 1904, to 4.1 per cent in 1905, to 5.1 per cent in 1906, to 6 per cent in 1907, to 7 per cent in 1908, 1909 and 1910, to 6.5 per cent in 1911, to 6.8 per cent in 1912, to 7 per cent in 1913, to 7.4 per cent in 1914 and 1915, to 7.6 per cent in 1916 and to 7.4 per cent in 1917.

Merrimack River.

The flow of the Merrimack River has been measured for many years at Lawrence, above which place the river has a total drainage area of 4,663 square miles which includes 118[1] square miles on the South Branch of the Nashua River, 75 square miles on the Sudbury River and 18 square miles tributary to Lake Cochituate, or a combined area of 211[1] square miles from which water is drawn at the present time for the supply of the Metropolitan Water District. The flow as measured at Lawrence includes the water wasted from these three drainage areas, the quantity of which, in the wet months of the year, is very considerable, but which becomes very small in the dry months. Records of the quantity of water wasted have been kept by the Boston Water Board and by the Metropolitan Water and Sewerage Board, and these

[1] Including 9.35 square miles from which water is drawn for the supply of the city of Worcester.

quantities have been deducted from the flow as measured at Lawrence. In presenting the record of the flow of the river, these three drainage areas have been deducted from the total above Lawrence, so that the net drainage area above that point was 4,567 square miles in 1880, 4,570 square miles in the years 1881 to 1897, inclusive, and 4,452 square miles since the latter year.

The average flow of the Merrimack River during the year 1918 amounted to 1.198 cubic feet per second, or 775,000 gallons per day, per square mile of drainage area, or 82 per cent of the normal flow for the past thirty-nine years for which records are available. The flow was in excess of the normal in the months of September, October, November and December, and less than the normal in the other eight months of the year.

In order to show the relation between the flow of this stream during each month of the year 1918 and the normal flow as deduced from observations during the thirty-nine years from 1880 to 1918, inclusive, the following table has been prepared: —

Table showing the Average Monthly Flow of the Merrimack River at Lawrence for the Year 1918 in Cubic Feet per Second per Square Mile of Drainage Area; also, the Departure from the Normal Flow.

Month.	Normal Flow, 1880-1918.	Actual Flow in 1918.	Excess or Deficiency.
January,	1.284	.466	—.818
February,	1.415	.819	—.596
March,	2.696	1.983	—.713
April,	3.415	3.337	—.078
May,	2.171	1.540	—.631
June,	1.264	.757	—.507
July,	.746	.553	—.193
August,	.684	.470	—.214
September,	.651	.847	+.196
October,	.811	.991	+.180
November,	1.108	1.126	+.018
December,	1.216	1.492	+.276
Average for whole year,	1.455	1.198	—.257

The following table gives the record of the net flow of the Merrimack River at Lawrence for each of the last three years, the flow being expressed in cubic feet per second per square mile of net drainage area: —

Flow of the Merrimack River at Lawrence in Cubic Feet per Second per Square Mile.

Month.	1916.	1917.	1918.	Mean for Thirty-nine Years, 1880-1918.
January,	1.527	1.023	.466	1.284
February,	1.674	.770	.819	1.415
March,	1.735	2.316	1.983	2.696
April,	4.323	3.242	3.337	3.415
May,	2.733	2.124	1.540	2.171
June,	3.101	3.037	.757	1.264
July,	1.531	1.024	.553	.746
August,	.924	.629	.470	.684
September,	.972	.549	.847	.651
October,	.798	.613	.991	.811
November,	.743	.882	1.126	1.108
December,	1.154	.569	1.492	1.216
Average for whole year,	1.768	1.398	1.198	1.455
Average for driest six months,	1.020	.711	.791	.869

Sudbury, Nashua and Merrimack Rivers.

The following table shows the weekly fluctuations during the year 1918 in the flow of the three streams just described, namely, the Sudbury River at Framingham, the South Branch of the Nashua River above Clinton, and the Merrimack River at Lawrence. The flow of these streams, particularly that of the Sudbury and of the South Branch of the Nashua River, serves to indicate the flow of other streams in eastern Massachusetts. The area of the Sudbury River watershed is 75.2 square miles and of the South Branch of the Nashua River 118.19 square miles. The net watershed area of the Merrimack River is 4,452 square miles.

Table showing the Average Weekly Flow of the Sudbury, South Branch of the Nashua and the Merrimack Rivers for the Year 1918 in Cubic Feet per Second per Square Mile of Drainage Area.

Week ending Sunday —	Cubic Feet per Second per Square Mile. Merrimack River at Lawrence.	Nashua River.	Sudbury River.	Week ending Sunday —	Cubic Feet per Second per Square Mile. Merrimack River at Lawrence.	Nashua River.	Sudbury River.
Jan. 6,	.419	.347	.030	July 7,	.569	.457	.070
13,	.407	1.069	.931	14,	.569	.353	.138
20,	.500	1.046	.531	21,	.621	.603	.370
27,	.502	.621	.311	28,	.470	.086	—.079
Feb. 3,	.477	.541	.357	Aug. 4,	.393	.427	.148
10,	.473	.614	.160	11,	.451	.483	.086
17,	.575	1.485	2.444	18,	.684	.194	—.019
24,	1.202	5.956	4.724	25,	.427	.077	—.272
Mar. 3,	1.506	6.258	6.221	Sept. 1,	.352	.319	—.120
10,	1.277	3.828	2.900	8,	.345	.207	—.278
17,	1.036	2.913	3.938	15,	.367	.491	.446
24,	2.339	5.391	3.456	22,	.590	1.448	1.345
31,	3.493	3.590	2.092	29,	1.995	1.790	2.317
Apr. 7,	4.684	2.613	1.703	Oct. 6,	1.308	.765	.934
14,	2.899	2.167	1.661	13,	1.223	.498	.497
21,	3.113	2.772	2.514	20,	.783	.341	.200
28,	3.047	2.239	2.910	27,	.830	.369	.209
May 5,	2.448	2.377	2.719	Nov. 3,	1.062	.513	.411
12,	1.698	1.097	1.180	10,	.869	.651	.527
19,	1.636	.752	.848	17,	.715	.792	.373
26,	.964	.713	.356	24,	1.751	1.654	1.656
June 2,	.805	.659	.215	Dec. 1,	1.162	.733	.715
9,	.691	.538	.036	8,	.941	.811	.579
16,	.745	.743	—.013	15,	.880	1.961	1.497
23,	.634	1.519	.854	22,	1.761	1.796	1.878
30,	1.004	.552	.330	29,	2.445	2.221	2.020

Sewerage and Sewage Disposal.

The war has made it impossible to carry out all the usual inspections of sewer outlets and sewage disposal works during the year, and it has also made impracticable the construction of additions to the existing works.

Examination of Sewer Outlets discharging into the Sea.

No important changes have been made in the various sewer outlets discharging into the sea or tidal waters during the past year. Improvements are greatly needed at a number of these outlets, especially at the sewer outlet of the city of Lynn and at that of the city of Beverly, and a sewerage system is greatly needed in the town of Danvers to remove the objectionable sources of pollution of local waters in that town. The sewer outlet of the cities of Salem and Peabody also could

be materially improved at a comparatively small cost, but under the conditions existing during the past year it has not been practicable to undertake such improvements.

Sewage Disposal in the Nashua River Valley.

The installation of sewage disposal works at Fitchburg has been followed by a marked improvement in the condition of the North Branch of the Nashua River below that city, but this improvement is largely offset by the entrance of the sewage of Leominster farther down the stream, and the condition of the river above its confluence with the South Branch at Lancaster has grown steadily worse in the past three years.

At Clinton, on the South Branch, the sewage is treated at disposal works and the effluent discharged into the river just above its confluence with the North Branch. The examinations of the main river below the junction of the North and South Branches show that its condition is growing worse, and above Ayer the river was considerably more polluted than was the case last year. Below Ayer, though the river receives the large quantity of effluent discharged through the sewage disposal works at Camp Devens, its condition was less objectionable than in the previous year.

At Camp Devens, in Ayer, the sewage disposal system, completed soon after the camp was occupied, has been in operation during the past year. The sewage is pumped to filter beds, 20 acres in area, located on high gravelly land in the northwesterly part of the town. The material of the filters is of excellent quality for the purpose, and beneath a deep layer of sand, strata of very coarse material are found, so that it was deemed unnecessary to provide underdrainage for the filters. The large quantity of sewage disposed of on this area sinks into the ground and doubtless finds its way to neighboring water courses, though no considerable outflow of effluent has been found at any point. The rate of operation has been higher than usual for sand filters, but the results of their operation have been excellent.

The most offensive pollution of the Nashua River or any of its tributaries is that which is caused by the sewage of the city of Leominster, which is discharged untreated into the streams near the city. During the year an experimental sewage disposal works was constructed at Leominster for the treatment of the sewage from a small area in the city, the quantity of sewage treated amounting apparently to about 75,000 gallons per day. The works consist of duplicate septic tanks, contact beds and trickling filters, the latter provided with a

limited amount of underdrainage for such filters. The trickling filters are each about one-sixth of an acre in area, only one having been used thus far. With one unit in use, the rate of operation of the trickling filter is only about one-third the rate at which trickling filters are usually operated with satisfactory results. When examined, the distribution upon the trickling filter was unsatisfactory, the effluent of very poor quality, and the odor about the works offensive. The results of the experiment thus far indicate that the treatment of the entire sewage of Leominster by works of this character would be inefficient and impracticable. Far better results could be obtained at less expense by the method already recommended. It is important for the protection of the public health in the Nashua River valley that the sewage of the city of Leominster shall be given proper treatment before it is discharged into the river, and the construction of suitable works should be begun without further delay.

Sewerage of the City of Worcester.

Experiments upon the treatment of the sewage of the city of Worcester by the activated sludge process, so called, were carried on from July 7, 1917, to Aug. 20, 1918, when the work was discontinued. The results of these experiments have not yet been summarized completely, but so far as available they indicate that, while the sewage of the city of Worcester could be treated successfully by this process, it would probably be a more difficult and expensive one to adopt than the method of disposal by trickling filters without any material offsetting advantages. The city is now in a position to proceed with the construction of new disposal works, plans for which are already being prepared. There appears to be nothing to prevent the carrying on of this work to completion without further study than is required in the preparation of suitable plans, though it is possible that legislation may be necessary to enable the city to obtain the funds required.

Sewerage in the Taunton River Valley.

Improvements in the sewerage works at Brockton have been carried on slowly during the year. New pumping machinery is being installed, and its capacity will soon be sufficient to pump all of the sewage to the disposal works and prevent further overflow into the Salisbury Plain River. Experiments are under way to determine the best practicable plan of enlarging the sewage disposal works and improving the character of the effluent in preparation for the construction of additional works as

soon as practicable. The revolving screen at the pumping station was abandoned in June, and the sewage is now applied to the trickling filter and the sand filters without preliminary treatment.

The town of Bridgewater is temporarily discharging its sewage into the Town River, but has prepared plans for works for the treatment of the sewage the construction of which has been postponed on account of the war.

The town of Middleborough prepared plans for the treatment of the sewage of that town many years ago, but has taken no further action in the matter.

The city of Taunton, acting through its sewer commissioners, began early in 1917 the preparation of plans of works for the treatment of its sewage, but owing to the lack of engineers on account of the war the work was discontinued. The cause of this delay being removed, it is expected that the work will be taken up again and carried to completion.

Sewage Disposal Systems.

The following is a list of the principal sewage disposal works now in operation in the State: —

Amherst.
Andover.
Attleboro.
Ayer (Camp Devens).
Billerica.
Brockton.
Clinton.
Concord.
Easthampton.
Fitchburg.
Framingham.
Franklin.
Gardner.
Hopedale.
Hudson.
Leicester
Lenox.
Longmeadow.
Marion.
Marlborough.
Maynard.
Medfield.
Milford.
Natick.
North Attleborough.
North Brookfield.
Northbridge.
Norwood.
Pittsfield.
Southbridge.
Spencer.
Stockbridge
Westborough.
Worcester.

Practically no work has been done in the enlargement or improvement of sewage disposal systems during the year 1918 on account of conditions brought about by the war. In consequence of these conditions, the additional filters which were under construction at Andover and Stockbridge in 1917 have not yet been completed, and the improve-

ments so essential to proper sewage disposal at Southbridge have not been begun. The extension of the Easthampton sewer outlet to the Connecticut River has also been postponed, together with the necessary improvements at Brockton, Milford and a number of other places. A decided improvement in the maintenance and operation of the filters at Framingham has greatly increased the efficiency of that works, notwithstanding the fact that the quantity of sewage was materially increased during the past year by the encampment of a large number of sailors at the old muster field. The sewage disposal works at Marlborough continue to give satisfactory results, and excellent results are also being obtained at Attleboro, Franklin, Hudson and many of the other places in the list.

A number of works are now greatly overtaxed, and additions and extensions are badly needed. Chief among these are the works at Southbridge, Natick, Northbridge, Milford and Andover. At Clinton the amount and character of the sewage are such as to overtax considerably the filter beds at the present time. It is probable that by reducing the amount of ground water entering the sewers, and by the treatment of the manufacturing wastes of the Bigelow Carpet Company (which contain an excessive quantity of fats) now discharged into the sewers, the works could be relieved of much of the load now discharged upon them and the efficiency of the treatment made satisfactory.

At some of the other works, particularly at Gardner and at Leicester, considerable quantities of sewage are discharged directly into the streams on account of the works being of inadequate capacity.

At Pittsfield sewage has been discharged from time to time into the Housatonic River, though the sewage disposal works in this case are probably adequate at present for the disposal of all of the sewage of the city.

At Northbridge the underdrainage system has been reconstructed and the beds resurfaced.

At Norwood additional filters previously laid out were completed during the year, and at Marion the filters were resurfaced.

Results of Examinations of Sewage and Effluent at Various Sewage Disposal Works, 1918.

The average results of the analyses of sewage and effluent, together with statistics concerning the more important sewage disposal works in the State, are presented in the following tables: —

TABLE NO. 1. — *Average Results of the Analyses of Monthly Samples of Sewage as received at the Disposal Works (Fats determined in about 69 Per Cent of the Samples).*

[Parts in 100,000.]

City or Town.	Residue on Evaporation. Total Residue. Total.	Residue on Evaporation. Total Residue. Dissolved.	Residue on Evaporation. Total Residue. Suspended.	Residue on Evaporation. Loss on Ignition. Total.	Residue on Evaporation. Loss on Ignition. Dissolved.	Residue on Evaporation. Loss on Ignition. Suspended.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Oxygen Consumed. Unfiltered.	Oxygen Consumed. Filtered.	Iron. Unfiltered.	Iron. Filtered.	Kjeldahl Nitrogen.	Fats.
Andover,	50.87	36.28	14.59	28.07	16.85	11.22	3.69	.87	.47	.40	7.11	5.70	3.27	.162	.071	1.49	8.01
ATTLEBORO,[1]	28.64	21.88	6.76	12.28	7.84	4.44	2.69	.41	.20	.21	4.56	2.72	1.30	.142	.072	.74	–
BROCKTON,	90.90	59.73	31.17	51.82	23.80	28.02	7.54	1.72	.80	.92	13.14	12.95	7.76	.314	.123	2.92	12.82
Clinton,	152.96	82.38	70.58	101.67	40.00	61.67	5.20	2.20	1.08	1.12	7.59	18.45	9.37	.729	.315	3.86	54.63
Concord,[2]	35.86	27.16	8.70	19.13	12.63	6.50	2.05	.49	.29	.20	4.87	3.76	2.53	–	–	.95	–
Easthampton,[2]	53.73	36.73	17.00	28.83	16.00	12.83	4.21	1.03	.58	.45	5.16	5.80	3.07	.235	.105	1.53	–
FITCHBURG,	53.10	32.18	20.92	23.92	13.52	10.40	2.14	.76	.45	.31	6.68	5.52	3.35	.889	.247	1.31	5.80
Framingham,	125.12	82.94	42.18	56.08	24.00	32.08	4.40	1.51	.85	.66	26.02	9.41	4.53	.346	.090	2.31	13.64
Franklin,[2]	42.43	27.07	15.36	21.80	12.13	9.67	2.73	1.14	.55	.59	3.46	5.43	2.46	–	–	1.42	–
Gardner (Gardner area),[3]	96.55	54.00	42.55	59.90	25.45	34.45	13.35	2.75	1.54	1.21	9.69	12.00	6.10	.260	.051	4.47	12.26
Gardner (Templeton area),	72.65	49.36	23.29	39.06	20.71	18.35	7.74	1.71	1.08	.63	10.17	7.18	3.92	.195	.049	3.05	8.14
Hopedale,[2]	52.90	37.23	15.67	32.83	20.10	12.73	7.32	1.54	.79	.75	6.88	7.13	4.02	–	–	2.13	–
Hudson,	138.67	113.75	24.92	42.57	25.05	17.52	6.30	1.62	.97	.65	44.83	9.33	5.28	.213	.077	2.88	8.65
Leicester,[3]	38.50	31.85	6.65	19.45	13.80	5.65	3.24	.64	.39	.25	5.31	2.98	2.06	.142	.041	.97	–
Marion,[4]	41.27	28.03	13.24	21.07	9.80	11.27	2.38	.57	.33	.24	7.30	3.59	1.88	.298	.068	.88	–
MARLBOROUGH,	70.98	45.48	25.50	37.92	17.66	20.26	4.81	1.28	.63	.65	9.69	8.21	4.02	.427	.127	2.31	10.20
Milford,	72.98	53.35	19.63	39.51	23.68	15.83	4.53	1.35	.86	.49	9.50	8.46	4.24	.184	.057	2.28	–
Natick,	51.45	41.75	9.70	21.30	14.74	6.56	3.14	.73	.42	.31	8.64	3.75	2.32	.273	.053	1.12	4.60
North Attleborough,[2]	32.17	25.17	7.00	13.93	9.60	4.33	1.38	.56	.26	.30	6.21	2.69	1.25	.140	.067	1.00	–
Northbridge,[2]	38.33	25.02	13.31	24.56	13.20	11.36	3.90	.98	.53	.45	3.73	4.22	2.43	–	–	1.47	–
Norwood,	108.68	88.64	20.04	35.68	23.04	12.64	4.44	.93	.43	.50	33.75	9.63	5.27	.285	.080	1.66	7.57
PITTSFIELD,	39.04	32.90	6.14	19.78	15.44	4.34	2.61	.57	.35	.22	4.64	3.36	2.12	.108	.050	1.02	3.06
Southbridge,[1]	51.12	34.76	16.36	26.76	15.16	11.60	4.14	.98	.54	.44	7.54	4.88	3.00	.294	.086	1.90	–
Spencer,[2]	37.80	27.77	10.03	21.07	13.10	7.97	3.78	.87	.45	.42	4.44	4.25	2.91	.192	.063	1.19	2.74
Stockbridge,[5]	24.40	21.47	2.93	10.13	8.07	2.06	1.11	.24	.14	.10	1.58	1.69	1.06	–	–	.38	–
Westborough,	56.63	43.17	13.46	30.12	20.37	9.75	2.80	.98	.58	.40	6.11	5.93	3.69	.382	.075	1.67	6.21
WORCESTER (day),[4]	118.00	76.47	41.53	46.47	18.13	28.34	3.04	1.77	.60	1.17	15.67	12.40	4.43	4.107	.393	–	–
WORCESTER (night),[1]	106.85	66.73	40.12	45.88	17.78	28.10	1.95	.95	.32	.63	11.88	11.35	4.34	5.900	2.875	1.97	–

[1] Five samples. [2] Every other month. [3] Four samples. [4] Six samples. May to October, inclusive. [5] Three samples.

TABLE NO. 2. — *Average Results of the Analyses of Monthly Samples of Sewage as applied to Filter Beds after Preliminary Treatment as indicated (Fats determined in about 69 Per Cent of the Samples).*

[Parts in 100,000.]

City or Town.	Form of Preliminary Treatment.	Residue on Evaporation. Total Residue. Total.	Total Residue. Dissolved.	Total Residue. Suspended.	Loss on Ignition. Total.	Loss on Ignition. Dissolved.	Loss on Ignition. Suspended.	Ammonia. Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.	Chlorine.	Oxygen Consumed. Unfiltered.	Oxygen Consumed. Filtered.	Iron. Unfiltered.	Iron. Filtered.	Kjeldahl Nitrogen.	Fats.
Andover,	Tank,	53.73	40.88	12.85	27.07	16.22	10.85	4.07	.88	.54	.34	7.76	5.85	3.64	.157	.082	1.67	7.16
ATTLEBORO,[1]	None,	28.64	21.88	6.76	12.28	7.84	4.44	2.69	.41	.20	.21	4.56	2.72	1.30	.142	.072	.74	–
BROCKTON,	Revolving screen,[2]	90.90	59.73	31.17	51.82	23.80	28.02	7.54	1.72	.80	.92	13.14	12.95	7.76	.314	.123	2.92	12.82
Clinton,	Basins,	64.27	52.64	11.63	30.75	23.12	7.63	3.45	.92	.62	.30	5.74	6.67	5.22	.735	.429	1.75	11.74
Concord,[3]	None,	35.86	27.16	8.70	19.13	12.63	6.50	2.05	.49	.29	.20	4.87	3.76	2.53	–	–	.95	–
Easthampton,[3]	Tanks,	50.43	37.20	13.23	28.30	17.53	10.77	4.22	.88	.50	.38	5.51	5.17	2.72	.225	.086	1.40	–
FITCHBURG,	Imhoff tanks,	38.33	32.45	5.88	15.62	13.03	2.59	2.59	.51	.33	.18	6.68	3.45	2.55	.490	.249	.86	3.04
Framingham,	None,	125.12	82.94	42.18	56.08	24.00	32.08	4.40	1.51	.85	.66	26.02	9.41	4.53	.346	.090	2.31	13.64
Franklin,[2]	Tanks,	27.47	23.97	3.50	11.70	8.83	2.87	2.10	.38	.28	.10	4.06	1.84	1.48	–	–	.65	–
Gardner[4] (Gardner area),	None,	96.55	54.00	42.55	59.90	25.45	34.45	13.35	2.75	1.54	1.21	9.69	12.00	6.10	.260	.051	4.47	12.26
Gardner (Templeton area),	Tanks,	43.71	38.03	5.68	17.82	15.08	2.74	3.97	.55	.43	.12	9.46	3.59	2.84	.120	.078	.94	3.60
Hopedale,[3]	Tanks,	34.57	27.86	6.71	19.47	14.23	5.24	4.84	.79	.47	.32	4.68	3.71	2.34	–	–	1.04	–
Hudson,	Tanks,	78.56	69.73	8.83	23.88	19.10	4.78	5.60	.74	.45	.29	24.51	4.33	2.95	.104	.048	1.22	4.00
Leicester,[4]	None,	38.50	31.85	6.65	19.45	13.80	5.65	3.24	.64	.39	.25	5.31	2.98	2.06	.142	.041	.97	–
Marion,[5]	None,	41.27	28.03	13.24	21.07	9.80	11.27	2.38	.57	.33	.24	7.30	3.59	1.88	.298	.068	.88	–
MARLBOROUGH,	Tanks,	53.38	43.42	9.96	23.65	17.72	5.93	3.70	.74	.48	.26	9.86	4.92	3.19	.569	.248	1.32	4.89
Milford,	Tanks,	52.17	41.98	10.19	23.42	15.61	7.81	4.34	.86	.49	.37	8.38	4.85	3.30	.194	.081	1.35	–
Natick,	None,	51.45	41.75	9.70	21.30	14.74	6.56	3.14	.73	.42	.31	8.64	3.75	2.32	.273	.053	1.12	4.60
North Attleborough,[3]	Tanks,	26.83	21.60	5.23	9.40	6.23	3.17	1.22	.23	.15	.08	5.95	1.26	.86	.216	.070	.43	–
Northbridge,[3]	Tanks,	16.01	13.28	2.73	6.83	4.58	2.25	1.58	.34	.20	.14	2.38	1.63	1.06	–	–	.66	–
Norwood,	Tank,	83.18	68.50	14.68	29.58	19.60	9.98	3.25	.67	.31	.36	24.09	7.01	4.49	.256	.108	1.40	4.53
PITTSFIELD,	None,	39.04	32.90	6.14	19.78	15.44	4.34	2.61	.57	.35	.22	4.64	3.36	2.12	.108	.050	1.02	3.06
Southbridge,[1]	Tanks,	33.36	27.92	5.44	15.84	12.28	3.56	3.45	.57	.41	.16	5.78	3.07	1.87	.202	.128	.93	–
Spencer,[3]	None,	37.80	27.77	10.03	21.07	13.10	7.97	3.78	.87	.45	.42	4.44	4.25	2.91	.192	.063	1.19	2.74
Stockbridge,[6]	None,	24.40	21.47	2.93	10.13	8.07	2.06	1.11	.24	.14	.10	1.58	1.69	1.06	–	–	.38	–
Westborough,	None,	56.63	43.17	13.46	30.12	20.37	9.75	2.80	.98	.58	.40	6.11	5.93	3.69	.382	.075	1.67	6.21
WORCESTER[6] (day),	Tanks,	118.00	76.47	41.53	46.47	18.13	28.34	3.04	1.77	.60	1.17	15.67	12.40	4.43	4.107	.393	–	–

[1] Five samples.
[2] Sewage as received at pumping station. Screen abandoned in June. Not in satisfactory operation early part of year.
[3] Every other month.
[4] Four samples.
[5] Six samples. May to October, inclusive.
[6] Three samples.

TABLE No. 3. — *Efficiency of Settling Tanks and Other Forms of Preliminary Treatment as indicated by the Foregoing Tables.*

[Parts in 100,000.]

City or Town.	Form of Preliminary Treatment.	Suspended Solids.			Total Albuminoid Ammonia.			Oxygen consumed.			Fats.[1]			Chlorine.		Approximate Period of Sedimentation, assuming Tanks contain no Deposits (Hours).	Frequency of Cleaning Tanks during Year.
		Raw Sewage.	Settled or Treated Sewage.	Per Cent removed.	Raw Sewage.	Settled or Treated Sewage.	Per Cent removed.	Raw Sewage.	Settled or Treated Sewage.	Per Cent removed.	Raw Sewage.	Settled or Treated Sewage.	Per Cent removed.	Raw Sewage.	Settled or Treated Sewage.		
Andover,	Tank,	14.59	12.85	12	.87	.88	-	5.70	5.85	-	8.01	7.16	11	7.11	7.76	¾–2½	Ten days to two weeks.
Clinton,	Basins,	70.58	11.63	84	2.20	.92	58	18.45	6.67	64	54.63	11.74	79	7.59	5.74	4–6	About once per month.
Easthampton,	Tanks,	17.00	13.23	22	1.03	.88	15	5.80	5.17	11	-	-	-	5.16	5.51	4–5	Four days to two months.
FITCHBURG,	Imhoff tanks,[2]	20.92	5.88	72	.76	.51	33	5.52	3.45	38	5.80	3.04	48	6.68	6.68	5½–11½	As often as sludge beds would allow.
Franklin,	Tanks,	15.36	3.50	77	1.14	.38	67	5.43	1.84	66	-	-	-	3.46	4.06	5½–6½	Fifteen times.
Gardner (Templeton area).	Tanks,	23.29	5.68	77	1.71	.55	68	7.18	3.59	50	8.14	3.60	56	10.17	9.46	6¼–8½	First tank each month, others two to six months.
Hopedale,	Tanks,	15.67	6.71	57	1.54	.79	49	7.13	3.71	48	-	-	-	6.88	4.68	20–30	Once.
Hudson,	Tanks,	24.92	8.83	65	1.62	.74	54	9.33	4.33	54	8.65	4.00	54	44.83	24.51	14–27	Once.
MARLBOROUGH,	Tanks,	25.50	9.96	61	1.28	.74	42	8.21	4.92	40	10.20	4.89	52	9.69	9.86	–[3]	Twelve times.
Milford,	Tanks,	19.63	10.19	48	1.35	.86	36	8.46	4.85	43	-	-	-	9.50	8.38	2½–3½	Three to four times.
North Attleborough,	Tanks,	7.00	5.23	25	.56	.23	59	2.69	1.26	53	-	-	-	6.21	5.95	2¾–3¾	Once.
Northbridge,	Tanks,	13.31	2.73	80	.98	.34	65	4.22	1.63	61	-	-	-	3.73	2.38	3¾–4¼	Once in two to four weeks.
Norwood,	Tank,	20.04	14.68	27	.93	.67	28	9.63	7.01	27	7.57	4.53	40	33.75	24.09	1¼–2¼	Six times.
Southbridge,	Tanks,	16.36	5.44	67	.98	.57	42	4.88	3.07	37	-	-	-	7.54	5.78	1¾–7¼	Ten times.
Worcester,	Chemical precipitation.	40.12	10.76	73	.95	.50	47	11.35	4.30	62	-	-	-	11.88	8.21	4–5	- - -

[1] Fats determined in about two-thirds of the samples.
[2] Five tanks. Flow reversed three times.
[3] Several compartments. Operated so as to get good sedimentation, but not to produce a septic effluent.

TABLE No. 4. — *Average Results of the Analyses of Monthly Samples of Sewage applied to the Trickling Filters at Brockton and Fitchburg, and of their Effluents, etc. Per Cents removed, etc.*

Brockton.

[Parts in 100,000.]

	Residue on Evaporation.						Ammonia.				Chlorine.	Nitrogen as —		Oxygen consumed.		Kjeldahl Nitrogen.	Fats.	Remarks.
	Total residue.			Loss on ignition.				Albuminoid.										
	Total.	Dissolved.	Suspended.	Total.	Dissolved.	Suspended.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.	Unfiltered.	Filtered.			
Screened sewage as applied to trickling filter.	57.74	42.68	15.06	30.94	18.72	12.22	5.63	1.09	.51	.58	9.80	-	-	7.44	3.87	3.06	5.52	The trickling filter has an area of .5 of an acre and a depth of 5.5 to 6.5 feet of crushed stone from 1.5 to 3 inches in size. The average rate of operation was 950,000 gallons per acre per day.
Effluent from trickling filter,	53.40	41.87	11.53	24.60	15.78	8.82	3.59	.89	.44	.45	9.88	1.0844	.0281	5.18	2.59	1.45	2.75	
Per cent removed, . .	8	-	23	20	-	28	36	18	-	22	-	-	-	30	33	30	50	
Settled effluent from trickling filter as applied to sand filters.	46 64	40.44	6.20	17.71	13.40	4.31	3.60	.63	.36	.27	10.70	.6944	.0188	4.14	2.82	1.02	1.93	
Per cent removed by tank, .	13	-	46	28	-	51	-	29	-	40	-	-	-	20	-	30	30	
Per cent removed by trickling filter and settling tank.	19	-	59	43	-	65	36	42	-	53	-	-	-	44	27	50	65	

TABLE NO. 4. — *Average Results of the Analyses of Monthly Samples of Sewage applied to the Trickling Filters at Brockton and Fitchburg, and of their Effluents, etc. Per Cents removed, etc.* — Concluded.

Fitchburg.

[Parts in 100,000.]

	Residue on Evaporation.						Ammonia.					Nitrogen as —		Oxygen consumed.				
	Total Residue.			Loss on Ignition.				Albuminoid.										
	Total.	Dissolved.	Suspended.	Total.	Dissolved.	Suspended.	Free.	Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Unfiltered.	Filtered.	Kjeldahl Nitrogen.	Fats.	Remarks.
Imhoff tank effluent as applied to trickling filter.	38.33	32.45	5.88	15.62	13.03	2.59	2.59	.51	.33	.18	6.68	-	-	3.45	2.55	.86	3.04	The trickling filter has an area of 2.14 acres and a depth of 10 feet of stone from 1 to 3 inches in size. The average rate of operation was about 1,290,000 gallons per acre per day.
Effluent from trickling filter,	36.67	29.65	7.02	16.02	11.71	4.31	.74	.30	.13	.17	6.74	1.3012	.0166	1.91	1.08	.50	1.33	
Per cent removed, . .	4	-	-	-	-	-	71	41	-	6	-	-	-	45	58	42	56	
Settled effluent from trickling filter as discharged to Nashua River.	34.38	30.25	4.13	14.03	11.42	2.61	.54	.20	.12	.08	6.84	1.2498	.0177	1.42	1.10	-	1.00	Period of sedimentation averaged about two and three-quarters hours. The tanks were cleaned six times from May to November.
Per cent removed by tanks,	6	-	41	12	-	39	27	33	-	53	-	-	-	26	-	-	25	
Per cent removed by trickling filter and settling tanks.	10	-	30	10	-	-	79	61	-	56	-	-	-	59	57	-	67	

TABLE NO. 5. — *Average Results of the Analyses of Monthly Samples of Effluent from Sand Filters.*

[Parts in 100,000.]

CITY OR TOWN.	Free Ammonia.	Total Albuminoid Ammonia.	Chlorine.	Nitrogen as — Nitrates.	Nitrogen as — Nitrites.	Iron.
Andover,[1]	1.94	.1752	8.97	.6723	.0176	.404
BROCKTON,	4.17	.1489	10.69	.1894	.0048	1.643
BROCKTON (sand filters used for settled trickling filter effluent).	2.26	.1329	12.03	.6782	.0047	1.104
Clinton,[1]	1.62	.1142	5.38	.2573	.0022	1.929
Concord,[3]	.44	.0308	4.25	.7758	.0062	.036
Easthampton,[2]	.30	.0678	4.89	1.5847	.0590	.083
Framingham,[1]	1.97	.1363	12.19	1.2916	.0290	1.211
Franklin,[2]	.89	.0567	3.63	1.1383	.0029	.066
Gardner (Gardner Area),[3]	2.56	.1400	7.95	3.8275	.0088	.098
Gardner (Templeton Area),[1]	2.68	.2990	11.44	1.9944	.0309	.077
Hopedale,[2]	1.48	.1508	4.57	2.2878	.0079	.026
Hudson,	1.21	.1324	25.45	1.6671	.0169	.257
Leicester,[3]	1.51	.2195	4.49	.1698	.0132	.555
Marion,[4]	.53	.0687	5.87	.7835	.0027	.074
MARLBOROUGH,[1]	1.37	.0806	8.31	2.1111	.0054	.102
Milford,	1.45	.1028	7.46	.8358	.0086	.513
Natick,	2.35	.0971	7.95	.2520	.0079	1.160
North Attleborough,[2]	.09	.0135	3.93	.7885	.0019	.008
Northbridge,	.92	.0877	3.19	.5316	.0120	.382
Norwood,	1.31	.0760	18.89	.3070	.0106	.546
PITTSFIELD,[4]	.82	.1054	4.09	.6786	.0136	.190
Southbridge,[5]	1.06	.0877	4.78	.8754	.0102	.595
Spencer,	.17	.0362	3.90	.9358	.0006	.017
Stockbridge,[6]	.22	.0610	3.04	.8544	.0049	.169
Westborough,[1]	.73	.1195	5.15	.7331	.0191	.404
WORCESTER,[7]	2.05	.1493	14.22	.9180	.0133	1.267

[1] Regular samples from two or more underdrains combined in one average.
[2] Every other month.
[3] Four samples.
[4] Several underdrains. December to February, inclusive, omitted.
[5] Several underdrains. Five months.
[6] Two samples from underdrains of sand beds and three from irrigation area.
[7] January, July and September.

NOTE. — Very little effluent has as yet appeared in underdrains at Attleboro. Concord effluent samples taken from spring.

TABLE No. 6. — *Efficiency of Sand Filters (Per Cent of Free and Albuminoid Ammonia removed).*

[Parts in 100,000.]

City or Town.	Free Ammonia.			Total Albuminoid Ammonia.			Chlorine.		Rate of Operation with [illegible] (Gal- [illegible] Day).[1]
	Applied Sewage.	Effluent.	Per Cent removed.	Applied Sewage.	Effluent.	Per Cent removed.	Applied Sewage.	Effluent.	
Andover,	4.07	1.94	52	88	.18	80	7 76	8 97	60,000
BROCKTON,	7.54	4.17	45	1.72	.15	91	13.14	10.69	62,000
BROCKTON (filters for settled trickling filter effluent).	3.60	2.26	37	.62	.13	79	10.70	12 03	68,000
Clinton,	3.45	1 62	53	.92	.11	88	5.74	[illegible]	41,000
Concord,[3]	2.05	.44	79	.49	.03	94	4.87	4 25	107,000
Easthampton,	4.22	.30	93	.88	.07	92	5.51	4.89	-
Framingham,	4.40	1.97	55	1.51	.14	91	26.02	12.10	44,000
Franklin,	2 10	.89	58	.35	.06	84	4.06	3 63	[illegible]
Gardner (Gardner area),[2]	13.35	2.56	81	2.75	.14	95	9.89	7 95	-
Gardner (Templeton area),	3.97	2.68	32	.55	.30	45	9.46	11 44	67,000
Hopedale,	4.84	1.48	69	79	.15	81	4.68	4.57	29,000
Hudson,	5.60	1 21	78	.74	.13	82	24.51	25.15	35,000
Leicester,	3.24	1 51	53	.64	.22	66	5 31	4.49	-
Marion,	2.38	53	78	.57	.07	88	7.30	5.87	[illegible]
MARLBOROUGH,	3 70	1 37	63	.74	08	89	[illegible]	8 31	42,000
Milford,	4 34	1.45	67	.86	.10	88	[illegible]	7.46	73,000
Natick,	3.14	2.35	25	.73	.10	86	8.64	7.95	65,000
North Attleborough,	1.22	.09	93	[illegible]	01	96	5.95	3.93	103,000
Northbridge,	1.58	.92	42	.34	.09	74	2 38	3 19	[illegible]
Norwood,	3.25	1.31	60	67	.08	88	24 09	18 89	95,000
PITTSFIELD,	2.61	82	69	.57	.11	81	4 64	4 09	81,000
Southbridge,	3.45	1 06	69	.67	[illegible]	84	5 78	4.78	115,000
Spencer,	3.78	17	96	.87	04	95	4 44	3.90	[illegible]
Stockbridge,	1.11	.22	80	.24	[illegible]	75	1.68	[illegible]	-
Westborough,	2 80	.73	74	98	.12	88	6.11	5.15	[illegible]
WORCESTER,	3 04	2.05	33	1.77	.15	92	15.67	14 22	67,000

[1] See also Table No. 7.

[2] See note at foot of Table No. 5.

[3] These filters given long periods of rest from time to time.

TABLE No. 7. — *Extent of Sewerage Works, Rate of Flow and Rate of Operation of Sand Filters, etc.*

City or Town.	Population, Census of 1915.	Approximate Length of Sanitary Sewers (Miles).	Approximate Number of House Connections.	Estimated Quantity of Sewage Treated (Gallons per Day). Average for Year.	Average for Month of Maximum Flow.	Average for Month of Minimum Flow.	Estimated Average Quantity of Sewage per Connection (Gallons per Day).	Net Area of Filter Beds (Acres).	Estimated Rate of Operation with Even Distribution (Gallons per Acre per Day).
Andover,	7,978	12.69	833	219,000	254,000	171,000	260	3.65[1]	60,000
Attleboro,	18,480	30.86	1,027	553,000	741,000	404,000	540	15.50	36,000
Brockton,	62,288	83.09	6,188	1,845,000[2]	2,324,000	1,336,000	370	30.00	62,000
				475,000[2]	808,000	–		7.00	68,000
Clinton,	13,192	21.00	1,525	1,066,000[2]	1,437,000	872,000	700	26.23	41,000
Concord,	6,681	8.69	461	460,000[2]	743,000	310,000	1,000	4.28	107,000
Easthampton,	9,845	24.00	1,160	500,000	–	–	430	2.20	–
Fitchburg,	39,656	–	–	2,757,000	4,109,000	1,963,000	–	–	–
Framingham,	15,860	25.75	2,279	934,000[2]	1,100,000	777,000	410	21.12	44,000
Franklin,	6,440	11.27	302	173,000	297,000	81,000	570	3.24	53,000
Gardner,	16,376	28.07	1,783	900,000	–	–	500	12.50[3]	72,000
Hopedale,	2,663	–	–	110,000[2]	–	–	–	3.79	29,000
Hudson,	6,758	9.69	624	317,000[2]	377,000	277,000	510	9.00	35,000
Leicester,	3,322	–	–	–	–	–	–	.36	–
Marion,	1,487	3.91	152	75,000[2]	–	–	490	.75	100,000
Marlborough,	15,250	29.05	2,063	870,000	1,532,000	429,000	420	20.90	43,000
Milford,	13,684	17.53	1,213	681,000	808,000	622,000	560	9.30	73,000
Natick,	11,119	–	–	822,000[2]	1,183,000	527,000	–	12.60	65,000
North Attleborough,	9,398	16.19	527	719,000[2]	800,000	626,000	1,360	7.00	103,000
Northbridge,	9,254	–	–	496,000	544,000	457,000	–	6.00	83,000
Norwood,	10,977	–	–	1,000,000	–	–	–	10.54	95,000
Pittsfield,	39,607	–	–	3,313,000[2]	3,858,000	–	–	41.15	81,000
Southbridge,	14,217	–	1,089	980,000	1,350,000	790,000	900	8.50	115,000
Spencer,	5,994	–	–	450,000	–	–	–	9.30	48,000
Westborough,	5,925	9.60	552	388,000	540,000	281,000	700	5.80	67,000
Worcester,	162,697	181.55[4]	–	4,890,000[5]	–	–	–	72.60	67,000

[1] A sludge bed with an area of .12 of an acre, and four filter beds with an aggregate area of .37 of an acre under construction.
[2] From pumping records.
[3] Gardner area, 2.50 acres. Templeton area, 10 acres.
[4] Includes 69.58 miles of combined sewers.
[5] Amount treated by sand filters. Total flow, 18,119,000 gallons per day.

TABLE No. 8. — *General Features.*

[For data concerning the trickling filters at Brockton and Fitchburg see Table No. 4.]

CITY OR TOWN.	Year of Construction of and Additions to Works.	Depth of Underdrains (Feet).	Distance Apart of Underdrains (Feet).	Filtering Material.	Attention given to Disposal Works.
Andover,	1896	4	20	avel; practically all	One man all the time.
ATTLEBORO,	1912, 1913	4-7	35	d in place,	One man all the time; others when necessary.
BROCKTON,	1893, 1905 1906, 1912	5.5	30	place,	Four men all the time; large force when necessary.
Clinton,	1898, 1899	8	60-70	Good sand and gravel; found in place,	Two men all the time; others when necessary.
Concord,	1899	none	–	Good sand underlaid with gravel; found in place,	One man once a day.
Easthampton,	1908	3.5	20-40	Good sand and gravel; largely found in place,	One man all the time; one other when necessary.
Framingham,	1890	4-4.5	30-40	Good sand and gravel,	Three or more men in summer; only one in winter.
Franklin,	1915	4.5	26	Good sand and gravel,	One man every two or three days; others when necessary.
Gardner (Gardner area),	1891	5	20		One man all the time.
Gardner (Templeton area),	1901, 1909	3-4	20-30		One man all the time; more when necessary.
Hopedale,	1900	3	25-60		One man all the time.
Hudson,	1904, 1910	5-6	50-100		One man all the time; others when necessary.
Leicester,	1894	4	8		Very little attention.
Marion,	1906	5	–	nd some	One man every day in summer; every other day in winter.
MARLBOROUGH,	1891, 1908 1909, 1910, 1911	4.5-6	30-60		One man all the time; others when necessary.
Milford,	1907	5	40		One man every day; others when necessary.
Natick,	1896	6	36	d in	One man all the time; others when necessary.
North Attleborough,	1909, 1910	5-6.5	55		One man every day; others when necessary.
Northbridge,	1906, 1907	4	50-75		One man all the time; others when necessary.
Norwood,	1909	4-6	40		One man every day; others when necessary.
PITTSFIELD,	1901, 1915	4	35		Two men all the time; others when necessary.
Southbridge,	1908	4	40	lled,	One man once a day.
Spencer,	1897	–[1]	–		One man all the time; others when necessary.
Stockbridge,	1899	3-4.5 3-4.5	23 30		One man all the time.
Westborough,	1892, 1911	5	20-40		One man all the time; others when necessary.
WORCESTER,	1898[2]	4-6	25-50		Several men all the time; a large force when necessary.

[1] Only 3 beds underdrained.

[2] Year of first construction of sand filters. Many additions.

Examination of Rivers.

In general, the pollution of the rivers of the State has increased in 1918 as compared with the previous year, and their condition in some cases has been more objectionable than for several years. A brief statement of the condition of the various rivers at the more important points is here presented: —

Aberjona River and Mystic Lakes.

The condition of the Aberjona River was satisfactory throughout the warmer part of the year, but late in the year there was an increase of organic matter in the stream, and the average quantity of organic matter in the water during the year has been somewhat greater at the entrance to Mystic Lake than in the previous year. The amount of acid present in the water, however, has been low.

By the provisions of chapter 34 of the Resolves of the year 1918 the Department was directed to ascertain the cost of constructing a sewer or sewers adequate for the disposal of the sewage and manufacturing waste now discharged into the Mystic Lakes in the towns of Arlington and Winchester and the city of Medford. It has been impracticable to complete this work during the past year, and a request has been made for an extension of time for carrying out this work.

Assabet River.

The condition of the Assabet River has shown but little change at any point during the past year as compared with the previous year. The river is still very badly polluted below Maynard, though its condition is somewhat less objectionable than was the case a few years ago.

Blackstone River.

The condition of the Blackstone River has shown no very material change in the past few years. When examined in the summer of 1918 the appearance of the stream was objectionable and its odor offensive throughout a large part of its course below Worcester.

Charles River.

The pollution of the Charles River has increased in 1918 throughout most of its course, but especially in the upper reaches in Medway and Medfield. The pollution of Mine Brook, one of its principal tributaries, has increased decidedly above the Franklin filter beds, and, though its

condition below the filters is much better, it still shows the effect of the pollution above. The pollution of this stream is largely due to manufacturing waste.

Chicopee River.

The condition of the Chicopee River has shown little change in the past year as compared with the previous year, and while this river receives considerable pollution it is not objectionable at the present time. Of its principal tributaries, the Quaboag, Ware and Swift rivers, the latter receives very little pollution of any kind except that which is caused by manufacturing waste discharged into the river in the lower portion of its course near its confluence with the Ware and Quaboag, which causes no seriously objectionable condition at the present time. The principal pollution of the Quaboag River is that which is caused by the sewage of Palmer, but the quantity of sewage discharged into the river up to the present time has not been sufficient to render it unsightly or seriously objectionable in any part of its course. The Ware River, on the other hand, is polluted by manufacturing wastes at several points along its course, and is seriously polluted below Ware by manufacturing waste and especially by the discharge from the sewers of the town.

The maintenance of proper sanitary conditions in this stream is likely soon to require the establishment of disposal works for treating the sewage of the town of Ware and the more objectionable manufacturing wastes.

Concord and Sudbury Rivers.

There has been little change in the condition of the Concord and Sudbury rivers as compared with previous years. The most objectionable pollution of the Sudbury River is at Saxonville, where the stream receives a large quantity of manufacturing waste and is notably polluted for a considerable distance below the village.

The condition of the Concord River above the city of Lowell has not been objectionable at any point during the past year. In the city of Lowell the river is badly polluted, especially by sewage from one of the main sewer outlets of the city which discharges into the stream a short distance above its confluence with the Merrimack. A plan for improving the condition of the Concord River was prepared by this Department several years ago, but the improvement has not been carried out.

Connecticut River.

The condition of this river has shown little change in the past year as compared with former years. It is not seriously polluted at any point at the present time.

Deerfield River.

The Deerfield River receives very little pollution through its course, except that which is caused by the sewage of the town of Greenfield, which is discharged into the river a short distance above its confluence with the Connecticut. The conditions about this outlet, however, have not been seriously objectionable during the past year.

French River.

The French River is very badly polluted at Webster by the sewage of the town and by manufacturing waste discharged from the mills. It is one of the most seriously polluted streams of the State, and investigations were begun just before the war for the removal of the sewage from this river and for its proper disposal. The work should be taken up again without delay and the pollution of the river by sewage prevented.

Hoosick River.

The Hoosick River is grossly polluted by the sewage of North Adams and Williamstown, and is offensive in the drier part of the year throughout its course from the North Adams sewer outlet to the point where it leaves the State. The region through which the river flows in Massachusetts is thickly populated and the river should be restored as soon as practicable to a proper sanitary condition, which can be accomplished by the removal of the sewage of North Adams and Williamstown and its treatment at suitable works.

Housatonic River.

The Housatonic River below Pittsfield has been somewhat more polluted than last year, though the increase has not been marked. In the lower part of its course in Stockbridge and Great Barrington there has been little change in its condition for several years. If all of the sewage of Pittsfield were pumped to the disposal works and filtered, the condition of the stream would not be noticeably objectionable at any point at the present time.

Merrimack River.

There has been little change in the condition of the Merrimack River throughout its course as compared with the previous year, and its condition has been considerably better in the past few years than formerly. Some of the tributaries of this river, notably Cochickewick Brook in North Andover, show an increase in pollution as compared with former years.

Miller's River.

The pollution of the Miller's River below Winchendon has increased somewhat during the past year, and there has been a slight increase in the pollution below Athol also, with little change in the remainder of its course. The river has not been noticeably objectionable at any point.

Neponset River.

The condition of the Neponset River has shown on the whole a slight deterioration in its upper waters above Hawes Brook as compared with the previous year. Hawes Brook below the tannery of the Winslow Brothers and Smith Company has been much more highly polluted than in the past two years, and the same is true of the condition of the river below Hawes Brook. In its course through the meadows, also, the pollution of the river has been greater than in the previous year, and its condition at Pauls bridge more objectionable than for several years. At its mouth at Milton Lower Mills the quantity of organic matter in the water of the river and the evidences of pollution have been somewhat greater than in the previous two years.

The difficulty in obtaining labor and chemicals for use as precipitants at the various works in this valley for the treatment of manufacturing wastes has for some time been serious, and these conditions have been largely responsible for the less efficient treatment of these wastes during the past year.

The sewage discharged at the disposal works at Norwood has been treated effectually during the year.

The town of Stoughton, at the headwaters of the Canton River, one of the principal tributaries of the Neponset River, which had been preparing for the construction of a sewage disposal system, found it necessary to postpone the work on account of the conditions brought about by the war. In the valley of the Canton River, also, the stream has been seriously polluted during the past year by wastes from a factory manufacturing khaki, disposal works for which have been partially completed. At other points in this valley there has been pollution of the streams by manufacturing waste which it has been found impracticable to prevent on account of the conditions brought about by the war.

Taunton River.

The condition of the Salisbury Plain River below Brockton has been very much worse than at any time since the Brockton sewerage works were completed, and this river was very badly polluted during the drier part of the year.

The Town River below Bridgewater also shows greater pollution than in any previous year, and the same is true of the condition of the Taunton River below the junction of the Town and Salisbury Plain rivers.

The Nemasket River also shows more evidence of pollution than for several years.

At Taunton there has been a deterioration in the condition of the Mill River, which has been badly polluted in its course through the city, and the quantity of organic matter in the water of the Taunton River itself below Taunton has been greater than in previous years.

Ten Mile River.

The Ten Mile River below Attleboro has been maintained in satisfactory condition during the past year.

Westfield River.

The most serious pollution of the Westfield River is that which is caused by the sewage of Westfield which is discharged into the river below the town. This river is not seriously polluted, and its condition has shown no material change as compared with previous years.

The results of chemical examinations of the more important rivers are presented in the following tables: —

Blackstone River.

CHEMICAL EXAMINATION OF WATER FROM BLACKSTONE RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Blackstone River, below Cherry Valley.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1909,	.35	13.93	3.34	.0681	.0470	.0334	.0136	3.70	.0125	.0003	.80	-
1910,	.32	16.42	3.92	.0633	.0489	.0387	.0102	4.02	.0146	.0002	.85	-
1911,	-	21.02	4.40	.1277	.0726	.0559	.0167	5.70	.0080	.0005	1.15	-
1912,[1]	-	44.10	11.04	.2514	.2884	.1023	.1861	10.70	.0002	.0004	3.08	-
1913,	-	32.32	6.52	.2591	.1628	.1122	.0506	8.18	.0015	.0004	2.06	-
1914,	-	44.73	7.27	.3430	.1857	.1379	.0478	12.83	.0000	.0001	2.12	-
1915,	-	19.23	5.15	.0985	.1142	.0785	.0357	3.08	-	-	1.89	-
1916,	-	14.18	5.27	.0209	.0809	.0544	.0265	1.25	-	-	1.50	-
1917,	-	20.67	7.48	.0406	.1279	.0762	.0517	2.36	-	-	2.20	-
1918,	-	18.43	4.95	.1209	.1125	.0666	.0459	2.10	-	-	1.48	-

[1] August omitted.

CHEMICAL EXAMINATION OF WATER FROM BLACKSTONE RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE — *Continued.*

Blackstone River, between Mill Brook Channel and the Sewage Precipitation Works of the City of Worcester.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Hardness.
					Albuminoid.						
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.	
1909,	-	52.97	18.55	.1865	.0381	.0239	.0142	4.80	.0033	.0010	-
1910,	0.15	50.92	18.97	.1933	.0545	.0309	.0236	4.07	.0023	.0009	-
1911,	0.11	44.64	15.70	.1920	.0449	.0212	.0237	4.03	.0170	.0009	-
1912,	0.10	40.05	10.91	.2047	.0352	.0225	.0127	3.58	.0027	.0011	-
1913,	0.10	35.17	10.34	.2767	.0491	.0285	.0206	3.18	.0003	.0008	-
1914,	0.14	35.03	8.23	.2993	.0771	.0510	.0261	3.85	.0012	.0018	-
1915,	0.13	39.00	11.68	.2383	.0650	.0392	.0258	2.96	-	-	-
1916,[1]	-	29.10	8.20	.2483	.0549	.0354	.0195	2.08	-	-	-
1917,[2]	0.23	42.38	11.04	.4864	.0612	.0379	.0233	2.19	-	-	-
1918,	0.20	37.36	10.23	.2917	.0728	.0322	.0406	2.23	-	-	-

[1] September omitted. [2] November omitted.

Blackstone River, below Sewage Precipitation Works.

Year.	Color.	Residue Total.	Loss on Ignition.	Ammonia Free.	Albuminoid Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Hardness.
1909,	-	53.79	12.12	1.0567	.1282	.0792	.0490	6.92	.0067	.0075	-
1910,	-	52.15	12.52	1.0090	.1654	.0817	.0837	5.68	.0015	.0034	-
1911,	0.21	53.25	13.15	.9967	.1608	.0651	.0957	6.54	.0152	.0072	-
1912,	0.23	48.90	10.08	1.1700	.1673	.0904	.0769	6.12	.0137	.0096	-
1913,[1]	0.28	40.68	10.46	.9320	.1286	.0719	.0567	4.49	.0158	.0084	-
1914,	0.25	43.46	9.08	.8577	.1114	.0770	.0344	4.87	.0038	.0091	-
1915,	0.18	39.45	6.77	.6370	.1032	.0575	.0457	3.58	-	-	-
1916,[1]	-	49.21	9.00	.6684	.1031	.0607	.0424	3.69	-	-	-
1917,[2]	-	50.37	12.46	.9350	.0926	.0610	.0316	4.25	-	-	-
1918,	0.61	39.03	8.40	.8590	.1370	.0687	.0683	3.42	-	-	-

[1] September omitted. [2] July omitted.

CHEMICAL EXAMINATION OF WATER FROM BLACKSTONE RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE — *Concluded.*

Blackstone River, at Uxbridge.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Hardness.
					Albuminoid.						
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.	
1909,	.22	18.31	4.35	.3473	.0273	.0216	.0057	3.64	.0325	.0066	-
1910,	.26	22.53	4.69	.4963	.0356	.0302	.0054	4.62	.0498	.0043	-
1911,	.26	23.10	3.85	.3717	.0293	.0225	.0068	4.15	.0558	.0173	-
1912,	.21	21.91	3.06	.4897	.0345	.0288	.0057	4.06	.0497	.0137	6.5
1913,	.29	19.48	3.70	.3880	.0355	.0281	.0074	3.34	.0382	.0107	5.5
1914,	.25	23.72	2.84	.5285	.0355	.0284	.0071	4.55	.0482	.0154	7.2
1915,	.30	19.63	2.75	.3068	.0381	.0302	.0079	3.10	-	-	6.3
1916,[1]	.32	20.42	4.72	.3766	.0376	.0293	.0083	2.74	-	-	6.3
1917,	.22	22.21	4.28	.3904	.0365	.0286	.0079	3.27	-	-	-
1918,	.36	19.23	4.12	.2555	.0354	.0280	.0074	3.26	-	-	-

[1] August omitted.

Blackstone River, at Millville.

Year.	Color.	Residue: Total.	Residue: Loss on Ignition.	Ammonia: Free.	Albuminoid: Total.	Albuminoid: Dissolved.	Albuminoid: Suspended.	Chlorine.	Nitrates.	Nitrites.	Hardness.
1909,	.24	11.87	3.17	.1595	.0267	.0220	.0047	2.27	.0225	.0019	-
1910,	.30	13.94	3.32	.2350	.0277	.0234	.0043	3.01	.0290	.0018	-
1911,	.33	14.35	2.79	.1787	.0268	.0222	.0046	2.94	.0355	.0051	-
1912,	.29	15.20	2.18	.2433	.0283	.0249	.0034	2.91	.0421	.0064	-
1913,	.37	12.92	2.38	.1631	.0281	.0237	.0044	2.44	.0345	.0063	-
1914,	.28	14.33	2.78	.2245	.0304	.0243	.0061	2.78	.0233	.0065	-
1915,	.42	13.55	2.02	.1379	.0361	.0267	.0094	2.12	-	-	-
1916,	.38	13.31	2.78	.2284	.0266	.0199	.0067	1.86	-	-	-
1917,	.33	14.19	3.96	.1572	.0286	.0222	.0064	2.12	-	-	-
1918,	.42	13.47	3.33	.1166	.0334	.0252	.0082	2.21	-	-	-

Charles River.

Chemical Examination of Water from Charles River. — Averages for Six Months, from June to November, inclusive.

Charles River, above Milford.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1914,[1]	.34	4.03	1.43	.0046	.0228	.0178	.0050	.41	.0000	.0000	.35	0.9
1915,[1]	.75	5.00	2.27	.0039	.0296	.0260	.0036	.41	-	-	.84	1.1
1916,[1]	.49	4.70	2.23	.0058	.0219	.0207	.0012	.37	-	-	.75	1.0
1917,	.43	4.96	1.58	.0062	.0197	.0157	.0040	.35	-	-	.53	1.3
1918,[2]	.37	4.15	1.26	.0096	.0209	.0155	.0054	.38	-	-	.41	1.2

[1] Three months. [2] Four months.

Charles River, below Milford.

1914,	.48	12.47	2.87	.2817	.0470	.0368	.0102	1.74	.0298	.0065	.74	3.3
1915,	.72	12.00	3.58	.1327	.0587	.0344	.0243	1.61	-	-	1.04	3.1
1916,[1]	.41	12.26	4.96	.1258	.0251	.0220	.0031	1.93	-	-	.81	2.9
1917,	.32	17.93	5.77	.4138	.0413	.0321	.0092	3.24	-	-	.49	3.7
1918,[2]	.61	10.33	3.10	.0519	.0531	.0366	.0165	1.71	-	-	.95	-

[1] October omitted. [2] Four months.

Charles River, opposite Pumping Station of Brookline Water Works.

1914,	.55	7.10	1.87	.0055	.0314	.0265	.0049	.92	.0032	.0001	.66	2.1
1916,[1]	.45	8.10	2.60	.0087	.0245	.0211	.0034	.96	-	-	.65	2.0
1917,	.70	7.93	2.72	.0053	.0394	.0270	.0124	.73	-	-	1.02	2.1
1918,[2]	.66	7.25	2.50	.0084	.0401	.0323	.0078	.86	-	-	.80	1.9

[1] Two months. [2] Three months.

Charles River, opposite Pumping Station of Waltham Water Works.

1914,	.52	7.45	1.98	.0117	.0353	.0297	.0056	.92	.0030	.0002	.57	2.6
1915,	.93	8.30	2.97	.0131	.0475	.0407	.0068	.91	-	-	1.11	2.3
1916,	.69	8.68	3.38	.0163	.0328	.0246	.0082	.89	-	-	.91	2.2
1917,	.67	7.68	2.75	.0109	.0310	.0282	.0028	.80	-	-	.71	2.3
1918,[1]	.49	6.60	2.27	.0101	.0384	.0272	.0112	.96	-	-	.61	2.2

[1] Three months.

Chicopee River.

CHEMICAL EXAMINATION OF WATER FROM CHICOPEE RIVER AND ITS TRIBUTARIES. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Ware River, below Ware.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as — Nitrates.	Nitrogen as — Nitrites.	Oxygen consumed.	Hardness.
1914,	.60	10.47	3.15	.0501	.0704	.0488	.0216	.53	.0012	.0006	.82	-
1915,	.76	9.43	3.41	.0317	.0746	.0427	.0319	.42	-	-	1.16	-
1916,	.79	7.37	2.82	.0148	.0451	.0334	.0117	.36	-	-	1.04	-
1917,[1]	.53	8.38	2.68	.0529	.0630	.0376	.0254	.44	-	-	.74	-
1918,	.66	8.08	3.26	.0319	.0647	.0414	.0233	.39	-	-	1.14	-

[1] July omitted.

Quaboag River, below Palmer.

Year.	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as — Nitrates.	Nitrogen as — Nitrites.	Oxygen consumed.	Hardness.
1914,	.49	6.62	1.62	.0144	.0243	.0176	.0067	.49	.0045	.0004	.35	-
1915,	.56	6.00	2.12	.0128	.0336	.0236	.0100	.40	-	-	.62	-
1916,	.64	6.02	2.54	.0134	.0278	.0209	.0069	.31	-	-	.70	-
1918,[1]	.26	5.70	1.88	.0149	.0220	.0156	.0064	.45	-	-	.41	-

[1] Four months.

Swift River, below Bondsville.

Year.	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as — Nitrates.	Nitrogen as — Nitrites.	Oxygen consumed.	Hardness.
1914,	.35	4.97	1.67	.0037	.0304	.0219	.0085	.20	.0025	.0002	.55	-
1915,	.46	4.95	1.83	.0052	.0269	.0202	.0067	.24	-	-	.64	-
1916,	.49	4.22	1.67	.0026	.0193	.0160	.0033	.18	-	-	.69	-
1917,	.33	5.07	2.02	.0034	.0224	.0166	.0058	.19	-	-	.50	-
1918,	.34	4.35	1.63	.0055	.0197	.0155	.0042	.21	-	-	.49	-

Chicopee River, above Chicopee.

Year.	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as — Nitrates.	Nitrogen as — Nitrites.	Oxygen consumed.	Hardness.
1914,	.33	6.50	2.00	.0163	.0278	.0212	.0066	.51	.0095	.0008	.40	-
1915,	.61	6.45	1.98	.0168	.0295	.0242	.0053	.39	-	-	.64	-
1916,[1]	.69	6.15	2.35	.0126	.0236	.0194	.0042	.32	-	-	.72	-
1917,[2]	.35	8.84	3.10	.0244	.0250	.0196	.0054	.36	-	-	.43	-
1918,[1]	.38	6.25	2.00	.0351	.0373	.0282	.0091	.46	-	-	.50	-

[1] Four months. [2] June omitted.

Concord River.

CHEMICAL EXAMINATION OF WATER FROM CONCORD RIVER AND ITS TRIBUTARIES. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Sudbury River, below Saxonville.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1914,	.51	9.62	3.03	.0292	.0439	.0276	.0163	1.13	.0220	.0042	.61	-
1915,	.97	6.67	2.75	.0129	.0408	.0319	.0089	.73	-	-	1.04	-
1916,[1]	.62	7.20	2.10	.0315	.0311	.0264	.0047	.93	-	-	.74	-
1917,	.52	7.30	2.70	.0185	.0481	.0306	.0175	.63	-	-	.73	-
1918,	.52	6.68	2.52	.0158	.0340	.0242	.0098	.71	-	-	.59	-

[1] June omitted.

Assabet River, above Westborough.

1914,	.92	7.37	2.78	.0088	.0356	.0304	.0052	.41	.0034	.0001	.98	-
1915,	1.56	8.08	4.02	.0046	.0453	.0406	.0047	.46	-	-	1.74	-
1916,	1.01	7.52	3.20	.0033	.0298	.0260	.0038	.47	-	-	1.24	-
1917,	.82	8.11	3.43	.0088	.0325	.0281	.0044	.57	-	-	1.11	-
1918,[1]	1.20	7.46	3.42	.0286	.0400	.0315	.0085	.56	-	-	1.31	-

[1] September omitted.

Assabet River, below Westborough.

1909,	1.70	19.24	8.91	.4140	.2281	.1616	.0665	1.94	.0005	.0005	2.90	-
1910,	2.23	17.07	7.00	.2898	.1334	.1018	.0316	2.16	.0078	.0018	2.20	-
1911,	.83	12.09	4.01	.0556	.0460	.0373	.0087	1.87	.0967	.0121	1.24	-
1912,	.66	12.71	4.01	.0975	.0419	.0357	.0062	2.20	.1998	.0132	.95	-
1913,	1.15	9.67	4.21	.0152	.0448	.0401	.0047	1.08	.1078	.0016	1.37	-
1914,	.80	10.21	3.14	.0089	.0399	.0339	.0060	1.59	.0195	.0005	1.01	-
1915,	1.62	9.46	4.28	.0118	.0539	.0438	.0101	.87	-	-	1.83	-
1916,	.88	11.30	4.38	.0807	.0360	.0319	.0041	1.87	-	-	1.12	-
1917,	.80	10.08	3.68	.0428	.0381	.0352	.0029	1.03	-	-	1.04	-
1918,[1]	.85	9.18	3.57	.0427	.0424	.0333	.0091	1.10	-	-	1.08	-

[1] September omitted.

Chemical Examination of Water from Concord River and its Tributaries, etc. — *Continued.*

Assabet River, above Hudson.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1914,	.44	6.80	2.10	.0066	.0275	.0222	.0053	.65	.0060	.0001	.53	-
1915,	.82	6.48	2.63	.0064	.0325	.0305	.0020	.55	-	-	1.02	-
1916,	.54	6.68	2.73	.0053	.0236	.0208	.0028	.61	-	-	.62	-
1917,	.50	6.64	2.26	.0057	.0288	.0223	.0065	.55	-	-	.57	-
1918,	.46	5.68	2.01	.0049	.0263	.0233	.0030	.71	-	-	.53	-

Assabet River below Hudson.

1909,	.51	8.81	3.26	.0161	.0403	.0296	.0107	.98	.0022	.0002	.64	-
1910,	.69	13.83	3.83	.0413	.0428	.0337	.0091	1.27	.0048	.0002	1.24	-
1911,	.64	12.83	4.30	.0817	.0532	.0400	.0132	.90	.0043	.0003	1.06	-
1912,	.78	18.08	3.99	.0939	.0752	.0494	.0258	1.02	.0053	.0002	1.28	-
1913,[1]	.76	13.29	3.34	.0727	.0704	.0577	.0127	1.07	.0036	.0004	1.28	-
1914,	.57	11.88	3.10	.0720	.0601	.0436	.0165	.98	.0042	.0002	1.03	-
1915,	.90	8.25	3.17	.0144	.0466	.0356	.0110	.59	-	-	1.16	-
1916,	.64	11.03	3.95	.0398	.0509	.0377	.0132	.70	-	-	.89	-
1917,	.63	10.36	3.57	.0250	.0522	.0376	.0146	.65	-	-	.77	-
1918,	.52	11.08	2.86	.0284	.0486	.0345	.0141	.77	-	-	.73	-

[1] November omitted.

Assabet River, above Maynard.

1914,	.46	7.02	2.39	.0069	.0373	.0308	.0065	.82	.0014	.0002	.53	-
1915,	.92	7.08	2 63	.0104	.0403	.0336	.0067	.63	-	-	1.03	-
1916,	.64	7.25	2.47	.0127	.0302	.0260	.0042	.67	-	-	.81	-
1917,	.57	7.95	2.57	.0204	.0361	.0276	.0085	.63	-	-	.68	-
1918,	.64	7.63	2.33	.0154	.0363	.0325	.0038	.82	-	-	.75	-

CHEMICAL EXAMINATION OF WATER FROM CONCORD RIVER AND ITS TRIBUTARIES, ETC. — *Concluded.*

Assabet River, below Maynard.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Oxygen consumed.	Hardness.
		Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
1909,	-	13.97	4.21	.1208	.0991	.0529	.0462	1.22	.0007	.0006	1.34	-
1910,	.59	13.15	4.68	.0708	.0685	.0446	.0239	1.82	.0038	.0006	.85	-
1911,	.58	12.73	4.17	.0738	.0650	.0408	.0242	1.41	.0060	.0006	1.08	-
1912,	-	12.94	3.92	.1205	.0771	.0494	.0277	1.46	.0026	.0010	1.04	-
1913,	.60	10.60	3.01	.0746	.0597	.0394	.0203	1.34	.0311	.0007	.85	-
1914,	.33	11.58	2.87	.0705	.0595	.0378	.0217	1.32	.0056	.0012	.73	-
1915,	.69	10.78	3.25	.0509	.0610	.0353	.0257	1.27	-	-	.99	-
1916,	.83	11.27	3.98	.0191	.0576	.0364	.0212	1.13	-	-	1.32	-
1917,	.67	12.08	4.14	.0684	.0832	.0440	.0392	1.30	-	-	1.07	-
1918,	.57	10.27	3.42	.0233	.0559	.0369	.0190	1.13	-	-	.81	-

Concord River, at Billerica.

1914,	.41	8.78	2.20	.0096	.0335	.0284	.0051	1.10	.0072	.0005	.50	-
1915,	.88	7.92	2.93	.0157	.0411	.0375	.0036	.84	-	-	1.05	-
1916,	.62	8.60	2.87	.0130	.0292	.0256	.0036	.85	-	-	.78	-
1917,	.54	7.42	2.32	.0166	.0321	.0268	.0053	.94	-	-	.55	-
1918,	.51	7.83	2.45	.0134	.0365	.0303	.0062	.94	-	-	.66	-

Connecticut River.

Chemical Examination of Water from Connecticut River. — Averages for Six Months, from June to November, inclusive.

Connecticut River, at Northfield Farms.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1914,	.29	8.03	2.73	.0056	.0182	.0137	.0045	.17	.0012	.0001	.70	-
1915,	.30	7.08	2.08	.0031	.0162	.0124	.0038	.17	-	-	.60	-
1916,[1]	.37	6.90	2.10	.0032	.0152	.0135	.0017	.14	-	-	.80	-
1917,[1]	.35	7.40	3.08	.0055	.0196	.0139	.0057	.13	-	-	.63	-
1918,	.33	6.93	2.20	.0041	.0186	.0142	.0044	.19	-	-	.80	-

[1] August omitted.

Connecticut River, below Springfield.

1914,	.29	7.92	2.50	.0185	.0243	.0178	.0065	.30	.0023	.0003	.82	-
1915,	.35	7.15	2.38	.0091	.0216	.0151	.0065	.24	-	-	.69	-
1916,	.37	7.82	3.09	.0067	.0173	.0143	.0030	.20	-	-	.77	-
1917,	.36	8.30	3.30	.0106	.0227	.0174	.0053	.22	-	-	.67	-
1918,	.33	7.48	2.60	.0168	.0236	.0149	.0087	.26	-	-	.77	-

Deerfield River.

Chemical Examination of Water from Deerfield River and Tributary. — Averages for Six Months, from June to November, inclusive.

Deerfield River, at Shelburne Falls.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1914,	.45	4.80	1.57	.0062	.0222	.0167	.0055	.17	.0022	.0003	.56	-
1915,	.27	4.58	1.44	.0042	.0149	.0121	.0028	.16	-	-	.39	-
1916,[1]	.34	4.50	2.23	.0033	.0129	.0117	.0012	.23	-	-	.55	-
1917,[2]	.22	4.97	1.90	.0035	.0113	.0093	.0020	.12	-	-	.20	-
1918,	.39	5.13	1.47	.0085	.0232	.0182	.0050	.23	-	-	.52	-

[1] Four months. [2] Three months.

CHEMICAL EXAMINATION OF WATER FROM DEERFIELD RIVER AND TRIBUTARY, ETC. — *Concluded.*

Deerfield River, below Green River.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Oxygen consumed.	Hardness.
		Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
1914,	.30	5.68	1.80	.0124	.0182	.0143	.0039	.19	.0020	.0001	.43	-
1915,[1]	.22	5.41	1.28	.0211	.0195	.0128	.0067	.20	-	-	.34	-
1916,	.29	5.60	1.47	.0226	.0160	.0127	.0033	.21	-	-	.43	-
1917,[2]	.24	8.68	2.90	.0161	.0187	.0148	.0039	.20	-	-	.36	-
1918,	.29	6.38	2.23	.0141	.0198	.0136	.0062	.25	-	-	.47	-

[1] Four months. [2] August omitted.

French River.

CHEMICAL EXAMINATION OF WATER FROM FRENCH RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

French River, below Webster.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Oxygen consumed.	Hardness.
		Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
1914,	.40	8.50	2.48	.0500	.0675	.0399	.0276	.72	.0018	.0027	.69	-
1915,	.53	8.38	3.02	.0472	.0778	.0448	.0330	.80	-	-	.88	-
1916,	.60	8.03	2.55	.0521	.0593	.0402	.0191	.84	-	-	.86	-
1917,	.48	7.85	3.08	.0428	.0645	.0367	.0278	.61	-	-	.72	-
1918,[1]	.50	9.00	3.75	.0162	.0779	.0416	.0363	.80	-	-	.96	-

[1] Four months.

Hoosick River.

CHEMICAL EXAMINATION OF WATER FROM HOOSICK RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Hoosick River, at Williamstown.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Oxygen consumed.	Hardness.
		Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
1914,	.39	18.62	4.02	.0670	.0584	.0381	.0203	.83	.0037	.0015	.63	9.5
1915,	.21	12.65	2.60	.0351	.0316	.0202	.0114	.49	–	–	.32	6.9
1916,[1]	.29	12.93	4.10	.0422	.0294	.0195	.0099	.67	–	–	.40	7.2
1917,[1]	.22	14.54	4.96	.0585	.0328	.0197	.0131	.59	–	–	.35	–
1918,[2]	.39	18.10	4.17	.0685	.0628	.0360	.0268	1.07	–	–	.76	–

[1] August omitted. [2] Three months.

Housatonic River.

CHEMICAL EXAMINATION OF WATER FROM HOUSATONIC RIVER AND ITS BRANCHES. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

East Branch, below Pittsfield.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Oxygen consumed.	Hardness.
		Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
1914,[1]	.24	13.82	3.27	.0509	.0351	.0271	.0080	.47	.0087	.0015	.53	–
1915,	.37	11.98	3.23	.0527	.0304	.0236	.0068	.35	–	–	.60	–
1916,	.34	12.67	4.00	.0496	.0292	.0225	.0067	.40	–	–	.54	–
1917,	.07	11.41	3.38	.0228	.0247	.0159	.0088	.22	–	–	.31	–
1918,[2]	.17	10.65	2.60	.0178	.0201	.0166	.0035	.34	–	–	.39	–

[1] Four months. [2] Two months.

West Branch, below Pittsfield.

Year.	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen consumed.	Hardness.
1914,[1]	.20	14.62	2.75	.0288	.0495	.0313	.0182	.45	.0017	.0011	.61	–
1915,[2]	.34	16.62	3.72	.0671	.0691	.0359	.0332	.65	–	–	.63	–
1916,	.18	12.93	3.78	.0568	.0432	.0228	.0204	.46	–	–	.29	–
1917,	.20	14.00	4.43	.0429	.0378	.0204	.0174	.38	–	–	.49	–
1918,[3]	.23	15.43	3.40	.0463	.0594	.0285	.0309	.65	–	–	.43	–

[1] Four months. [2] September omitted. [3] Three months.

CHEMICAL EXAMINATION OF WATER FROM HOUSATONIC RIVER AND ITS BRANCHES, ETC. — *Concluded.*

Southwest Branch, at Pittsfield.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as — Nitrates.	Nitrogen as — Nitrites.	Oxygen consumed.	Hardness.
1914,[1]	.16	15.05	2.30	.0098	.0259	.0166	.0093	.24	.0072	.0005	.37	-
1915,	.14	15.25	2.95	.0070	.0243	.0159	.0084	.26	-	-	.30	-
1916,	.15	14.97	4.69	.0038	.0197	.0122	.0075	.20	-	-	.30	-
1917,	.17	16.98	4.30	.0326	.0292	.0172	.0120	.36	-	-	.35	-
1918,[2]	.14	15.76	3.87	.0188	.0201	.0155	.0046	.32	-	-	.22	-

[1] Four months. [2] Three months.

Housatonic River, below Great Barrington.

Year.	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as — Nitrates.	Nitrogen as — Nitrites.	Oxygen consumed.	Hardness.
1914,[1]	.22	17.62	4.22	.0147	.0372	.0268	.0104	.69	.0112	.0023	.42	-
1915,	.23	15.83	3.60	.0142	.0296	.0183	.0113	.46	-	-	.47	-
1916,[2]	.22	15.40	5.80	.0143	.0230	.0174	.0056	.49	-	-	.40	-
1917,[3]	.19	15.76	4.30	.0130	.0295	.0196	.0099	.52	-	-	.43	-
1918,	.21	16.65	4.97	.0166	.0273	.0210	.0063	.61	-	-	.41	-

[1] Four months. [2] June omitted. [3] September omitted.

Merrimack River.

CHEMICAL EXAMINATION OF WATER FROM MERRIMACK RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Merrimack River, above Lowell.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as — Nitrates.	Nitrogen as — Nitrites.	Oxygen consumed.	Hardness.
1914,	.30	5.32	1.74	.0170	.0255	.0181	.0074	.35	.0037	.0003	.61	1.6
1915,	.46	5.43	2.18	.0140	.0273	.0205	.0068	.32	-	-	.79	1.3
1916,[1]	.50	6.02	2.06	.0078	.0197	.0169	.0028	.25	-	-	.77	1.3
1917,	.34	6.58	2.12	.0117	.0222	.0166	.0056	.36	-	-	.54	1.4
1918,	.37	5.88	2.05	.0140	.0238	.0191	.0047	.42	-	-	.72	1.5

[1] October omitted.

CHEMICAL EXAMINATION OF WATER FROM MERRIMACK RIVER, ETC. — *Concluded.*

Merrimack River, above Lawrence.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1914, . . .	.23	6.85	2.62	.0280	.0246	.0201	.0045	.59	.0190	.0003	.59	1.7
1915, . . .	.33	7.05	2.83	.0183	.0230	.0177	.0053	.47	.0139	.0002	.69	1.6
1916, . . .	.47	6.89	2.77	.0143	.0211	.0146	.0065	.43	.0175	.0004	.55	1.4
1917, . . .	.44	6.54	2.53	.0147	.0203	.0169	.0034	.50	.0147	.0007	.47	1.2
1918, . . .	.45	7.10	2.88	.0176	.0233	.0174	.0059	.53	.0132	.0010	.66	1.2

Miller's River.

CHEMICAL EXAMINATION OF WATER FROM MILLER'S RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Miller's River, below Miller's Falls.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1914, . . .	.44	5.17	1.85	.0073	.0251	.0204	.0047	.36	.0068	.0003	.49	-
1915, . . .	.88	5.77	2.75	.0092	.0311	.0256	.0055	.31	-	-	.93	-
1916, . . .	.80	4.85	2.14	.0093	.0274	.0212	.0062	.31	-	-	.97	-
1917, . . .	.75	5.90	2.75	.0058	.0281	.0224	.0057	.25	-	-	.78	-
1918, . . .	.62	4.90	1.67	.0058	.0267	.0226	.0041	.32	-	-	.73	-

Nashua River.

Chemical Examination of Water from Nashua River. — Averages for Six Months, from June to November, inclusive.

North Branch of Nashua River, below Fitchburg.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1909,	.52	15.85	3.42	.3220	.0958	.0563	.0395	1.87	.0027	.0014	1.02	–
1910,	.60	20.11	4.90	.4047	.1235	.0789	.0446	2.29	.0017	.0009	1.03	–
1911,	.51	19.38	5.57	.2848	.1035	.0566	.0469	2.37	.0027	.0015	1.15	–
1912,	.57	19.52	4.99	.2380	.1007	.0560	.0447	2.20	.0032	.0019	1.22	–
1913,	.40	23.45	4.97	.2770	.1064	.0561	.0503	2.02	.0028	.0013	1.42	5.0
1914,	.41	26.93	5.78	.3260	.1156	.0662	.0494	2.60	.0020	.0006	1.55	5.9
1915,[1]	.41	14.68	3.52	.0578	.0745	.0296	.0449	1.26	–	–	.94	3.1
1916,[2]	.42	18.52	5.12	.1043	.0778	.0380	.0398	2.12	–	–	1.03	3.2
1917,	.42	15.66	4.00	.0433	.0702	.0394	.0308	1.68	–	–	.74	–
1918,	.49	19.87	6.02	.0602	.0800	.0431	.0369	2.12	–	–	1.04	–

[1] October omitted. [2] August omitted.

North Branch of Nashua River, at Lancaster.

Year.	Color.	Residue: Total.	Residue: Loss on Ignition.	Ammonia: Free.	Albuminoid: Total.	Albuminoid: Dissolved.	Albuminoid: Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen consumed.	Hardness.
1909,	.44	12.26	3.41	.1556	.0330	.0284	.0046	1.46	.0360	.0066	.60	–
1910,	.45	13.44	3.82	.1655	.0462	.0366	.0096	1.63	.0388	.0108	.70	–
1911,	.51	15.64	4.10	.3067	.0828	.0408	.0420	1.95	.0208	.0083	.92	–
1912,	.45	12.65	3.10	.1252	.0438	.0275	.0163	1.68	.0343	.0083	.72	–
1913,	.43	15.45	3.02	.2292	.0533	.0386	.0147	1.75	.0133	.0053	.80	4.2
1914,	.39	16.80	3.15	.2147	.0466	.0336	.0130	1.94	.0262	.0115	.67	4.1
1915,	.42	12.10	3.49	.0757	.0465	.0294	.0171	1.31	–	–	.68	2.4
1916,[1]	.41	12.34	3.92	.0539	.0336	.0257	.0079	1.28	–	–	.73	2.7
1917,	.32	14.28	2.82	.0542	.0343	.0240	.0103	1.52	–	–	.51	–
1918,	.31	13.83	3.22	.0755	.0392	.0291	.0101	1.98	–	–	.55	3.4

[1] October omitted.

Nashua River, at Pepperell.

Year.	Color.	Residue: Total.	Residue: Loss on Ignition.	Ammonia: Free.	Albuminoid: Total.	Albuminoid: Dissolved.	Albuminoid: Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen consumed.	Hardness.
1914,[1]	.31	12.67	2.75	.0595	.0459	.0286	.0173	1.27	.0132	.0027	.59	–
1915,	.46	8.25	2.27	.0222	.0328	.0237	.0091	.85	–	–	.63	–
1916,[2]	.43	8.57	2.33	.0191	.0248	.0197	.0051	.78	–	–	.57	–
1917,	.39	10.96	4.06	.0434	.0357	.0204	.0153	1.25	–	–	.54	–
1918,	.31	10.75	3.00	.0338	.0305	.0210	.0095	1.53	–	–	.51	–

[1] Two months. [2] Three months.

Neponset River.

CHEMICAL EXAMINATION OF WATER FROM NEPONSET RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Neponset River, at Hyde Park.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1909,	–	28.69	9.08	.1723	.1218	.0898	.0320	5.35	.0027	.0009	2.02	10.0
1910,	–	31.37	10.16	.1740	.1333	.1000	.0333	5.84	.0010	.0002	2.96	10.4
1911,	1.24	18.82	5.49	.0786	.0727	.0539	.0188	3.36	.0025	.0007	1.86	7.1
1912,	.82	26.02	6.45	.1241	.1020	.0707	.0313	4.18	.0017	.0012	2.31	9.2
1913,	1.02	26.13	6.22	.0533	.0757	.0494	.0263	3.93	.0020	.0007	2.29	7.9
1914,	.93	20.27	4.37	.0754	.0697	.0484	.0213	3.43	.0025	.0008	1.31	5.2
1915,[1]	1.23	19.67	6.30	.0530	.1078	.0649	.0429	2.42	–	–	1.92	5.3
1916,	1.28	19.47	5.37	.0466	.0761	.0554	.0207	2.37	–	–	1.96	–
1917,	.93	15.55	6.40	.0474	.0599	.0394	.0205	1.88	–	–	1.09	–
1918,	.87	19.65	5.87	.0968	.0808	.0494	.0314	2.68	–	–	1.51	–

[1] Four months.

Quinebaug River.

CHEMICAL EXAMINATION OF WATER FROM QUINEBAUG RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE

Quinebaug River, below Southbridge.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1914,	.52	11.93	2.36	.3033	.0514	.0323	.0191	2.41	.0078	.0052	.47	–
1915,	.68	7.56	2.49	.1499	.0457	.0327	.0130	.82	–	–	.91	–
1916,	.54	8.12	3.32	.0867	.0367	.0266	.0101	.52	–	–	.76	–
1917,	.42	5.32	1.65	.0380	.0297	.0201	.0096	.35	–	–	.47	–
1918,	.50	7.35	2.77	.0471	.0351	.0256	.0095	.53	–	–	.64	–

Taunton River.

CHEMICAL EXAMINATION OF WATER FROM TAUNTON RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Taunton River, below Taunton.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1914, ...	.92	18.10	3.33	.0701	.0389	.0323	.0066	5.95	.0100	.0020	.88	-
1915, ...	1.35	9.38	3.38	.0469	.0465	.0374	.0091	1.24	-	-	1.34	-
1916, ...	1.70	9.58	3.72	.0323	.0424	.0341	.0083	1.20	-	-	1.74	-
1917, ...	1.36	9.05	3.98	.0345	.0423	.0336	.0087	1.31	-	-	1.30	-
1918, ...	1.25	9.43	3.73	.0578	.0514	.0382	.0132	1.23	-	-	1.40	-

Ten Mile River.

CHEMICAL EXAMINATION OF WATER FROM TEN MILE RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Ten Mile River, below Attleboro.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1914, ...	.51	15.32	3.09	.1909	.0673	.0401	.0272	1.73	.0300	.0087	.77	-
1915,[1]	.88	11.10	3.30	.0954	.0494	.0346	.0148	1.37	-	-	.98	3.2
1916, ...	-	13.23	3.42	.0912	.0510	.0340	.0170	1.66	-	-	.91	3.0
1917,[2]	.72	10.62	3.72	.0613	.0349	.0250	.0099	1.08	-	-	.66	-
1918,[3]	.56	10.46	3.73	.0221	.0584	.0317	.0267	1.14	-	-	.80	-

[1] June omitted. [2] November omitted. [3] Three months.

Westfield River.

CHEMICAL EXAMINATION OF WATER FROM WESTFIELD RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Westfield River, below Westfield.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1914,	.15	6.50	1.72	.0255	.0255	.0161	.0094	.33	.0101	.0013	.26	-
1915,	.23	5.70	1.78	.0191	.0224	.0159	.0065	.27	-	-	.38	-
1916,	.25	6.58	2.62	.0258	.0183	.0139	.0044	.26	-	-	.39	-
1917,	.15	6.04	2.20	.0379	.0193	.0154	.0039	.31	-	-	.28	-
1918,	.19	6.90	2.43	.0230	.0186	.0133	.0053	.32	-	-	.22	-

PROTECTION OF THE PUBLIC HEALTH IN THE VALLEY OF THE NEPONSET RIVER.

Upon the completion of the work of dredging the Neponset River, required by chapter 655 of the Acts of the year 1911, the State Department of Health was directed by the provisions of chapter 265 of the General Acts of the year 1916 to make return to the Treasurer of the Commonwealth, and to the assessors of the towns named in the act, of schedules and plans showing the parcels of land benefited by the work done or changes made under the act, the areas of the parcels, the names of the owners or occupants thereof so far as they can be ascertained, together with the amount of the benefits accruing to each of the parcels, etc., and an appropriation of $5,000 was made for carrying out the work.

At the beginning of the war the entire force which made the field surveys, the investigations as to ownership and as to the various parcels of land benefited by the work done entered the army, and other men engaged to take their places soon followed. In consequence the work was greatly delayed and its cost greatly increased.

In 1918 a further appropriation was made for completing this work. It has not been found practicable to secure sufficient assistance, however, and the work has been continued from time to time as rapidly as men could be obtained or spared for the purpose. The field work has now been practically completed, except such as may be necessary for

verification in a few areas. Practically all the land titles have been investigated and three-quarters of them checked. Ten maps have been made of the territory comprised in the meadows and are now in process of completion on a scale of 200 feet to the inch, and an index plan on a scale of 800 feet to the inch is being prepared. Observations are being made upon the height of ground water in various parts of the meadows, but plans of the results of these observations have yet to be made. If it is practicable to continue the work steadily with a suitable force, it can be finished in a few months in such form as to enable the Department to complete its work.

During the past year a company engaged in the preparation of peat for fuel, fertilizer and other uses has excavated pits in the deep layers of peat in the Purgatory Brook section of the Neponset valley. These pits have become filled with water and have been found to be breeding places for mosquitoes. Such pits if abandoned might entail considerable expense in future years for draining, filling or other work incidental to preventing nuisance and injury to health from mosquito growths. It is somewhat difficult to frame legislation to prevent nuisances of this sort without danger of interfering with desirable enterprises; nevertheless, some action is likely to be necessary to prevent danger of serious nuisance and trouble from this cause.

Pollution of a Stream in Mansfield by Manufacturing Wastes.

Early in July a petition was received from the town of Mansfield for action by the Department in relieving a serious nuisance in that town created by the discharge of manufacturing waste mingled with hot water into a swamp located in a populous neighborhood. In accordance with orders of the Department, a change was effected in the method of treatment and disposal of the wastes from the factory, and a considerable relief from the nuisance was effected before further serious trouble was removed by the advent of cold weather. Certain additional improvements in the disposal of waste at this factory will have to be effected before another summer if a further nuisance is to be prevented.

Work required by Special Legislation.

Under the legislation of 1918 a considerable amount of work was committed to this Department in connection with special investigations under the following special acts of the Legislature: —

Hale's Brook in Lowell. (Chapter 92, Resolves of 1917, and Chapter 24, Resolves of 1918.)

Disposal of sewage in the town of Ayer. (Chapter 58, Resolves of 1918.)

Use of water from the Ipswich River. (Chapter 73, Resolves of 1917, and Chapter 26, Resolves of 1918.)

Cost of a sewerage system to prevent the pollution of the Mystic Lakes. (Chapter 34, Resolves of 1918.)

Utilization of peat for fuel. (Chapter 49, Resolves of 1918.)

The engineering work in connection with the foregoing matters has been carried out by the Engineering Division of this Department. Special reports have been presented to the Legislature relating to Hale's Brook in Lowell, and to a sewerage system for the town of Ayer, but it has been impracticable to obtain the necessary engineering force to carry out all of the work committed to the Department by the above legislation, and an extension of time has been requested to complete the study of the question of further water supply from the Ipswich River and to make the investigation relative to a sewerage system to prevent the pollution of the Mystic Lakes.

DIVISION OF WATER AND SEWAGE LABORATORIES.

H. W. CLARK, *Director and Chief Chemist.*

REPORT OF DIVISION OF WATER AND SEWAGE LABORATORIES.

A large amount of analytical and research work concerning problems of water supply, water purification, sewage and sewage disposal, the treatment of trade wastes, etc., was done as usual by this Division during the year 1918. This work was carried on under the provisions of the act entitled "An Act to protect the purity of inland waters of the State," and also to carry out the provisions of many special acts concerning the public welfare and the public health as related to water supply, sewerage, conditions of rivers, etc.

During the year examinations were made of practically all the public water supplies in the State, of the rivers in the State to determine their degree of pollution, of the sewage applied to and of the effluents from sewage disposal areas, and of wastes from factories, together with many samples of effluent from the purification works at these factories, experimental purification plants, etc.

During 1918, 4,640 samples of water, sewage, etc., were analyzed in the State House laboratories, and 2,601 microscopical and special chemical examinations were made, divided approximately as follows: —

Samples from public water supplies: —	
Surface waters,	1,500
Ground waters,	952
Samples from rivers,	977
Samples from sewage disposal works: —	
Sewages,	404
Filter effluents,	587
Samples of wastes and effluents from factories,	153
Samples of sea water from various locations,	67

Special examinations of water for manganese, lead, nickel, copper, zinc, etc.,	233
Determinations of fats, alkalinity, etc.,	403
Microscopical examinations,	1,443
Determinations of dissolved oxygen, carbonic acid, etc. (field work),	522

Much necessary investigating or research work is carried on by this Division in regard to methods of treatment or purification of water, sewage, factory wastes, etc., and many filters and other apparatus are kept in operation at the experiment station in connection with these studies. The station is also the bacterial laboratory for all this work upon water supply, sewerage and sewage disposal.

At the station laboratories 5,817 examinations were made during the year, divided as follows: —

Samples examined on account of investigations concerning the disposal of domestic sewage, trade wastes, etc.,	1,023
Chemical examinations on account of investigations in connection with filtration and other treatments of water supplies, swimming pools, etc.,	708
Chemical examinations of sand from filter areas,	42
Mechanical examinations of sand from filter areas,	45
Bacterial examinations of water, sewage, ice, trade wastes, etc.,	3,962
Bacterial examinations of shellfish,	37

As indicated above, such investigations in regard to the treatment and purification of water, sewage, trade wastes, etc., as appeared to be essential to the work of the Department were carried on as usual during 1918, and the most important of these can be summarized as follows: —

Acid Treatment of Sewage. — During 1917 this Department made an investigation of the so-called "Miles acid process of sewage treatment," this process being, briefly, the treatment of sewage with SO gas for collection of the sludge present and the recovery of the valuable ingredients in this sludge. This investigation was made for a special commission of three, appointed by the Legislature, of which the State Commissioner of Health was a member. The results of this investigation were briefly summarized in a legislative document, House, No. 1215, January, 1918.

It seemed worth while, as the subject was important, to continue work on this method during 1918. The results of the work are given on subsequent pages, and they largely confirm the 1917 statements concerning the place of this process in sewage disposal work. Extensive investigations in regard to this Miles acid process were made at New Haven, Conn., during the year, and the results obtained there are in substantial agreement with those obtained by us during the past two years, namely, that it is a method of sewage treatment that may be used to advantage by some municipalities, but not with the expectation of financial profit.

Activated Sludge. — Further work of importance has been done with the activated sludge process of sewage disposal. One of the chief items of interest in this process is the possibility of the recovery of fairly stable sludge of commercial value, and this was quite thoroughly studied during the year with such activated sludge tanks as are in operation at Lawrence. The figures in regard to the entering sludge that can be recovered are given later, together with figures of the nitrogen and fat content of such sludge. It has been shown that in this process, as in all successful sewage purification processes, there is a large loss of nitrogenous and other organic matter due to the oxidizing conditions existing in these activated sludge tanks.

Further work has been carried on in regard to the purification of the effluents from such activated tanks, and much work done to determine the volume of air necessary for agitation of sewage in tanks of various depths and the volume necessary per gallon of sewage treated to obtain a satisfactorily purified effluent. Studies have also been continued in regard to the most satisfactory percentage of sludge compared with the total volume of sewage held by the activated sludge tanks that must be kept in agitation in the sewage to obtain satisfactory results. A fairly complete summary of this work is given later.

Treatment of Trickling Filter Effluents by the Activated Sludge Method. — Considerable study was made during the year in regard to the treatment by the activated sludge process of rather poorly purified trickling filter effluents such as come from filters of coarse filter material and operated at high rates, and the results have seemed to show that at certain trickling filter areas the effluent can be treated in this way to considerable advantage as far as end results are concerned, as shown later.

Recovery of Sludge from Trickling Filter Effluents. — At the present time studies are being made the world over in regard to the recovery of what has heretofore been considered at most sewage plants as unavoidable wastes, namely, the sludge or matters in suspension containing nitrogenous bodies and fats. Great efforts are being made at the present time to develop methods for the recovery of this material, and as one study of such recovery, considerable investigation has been made during the year regarding the amount of matter in suspension in trickling filter effluents; the value of this material; the rapidity of sedimentation of such material when these effluents are passed through suitable tanks, etc. The results summarized on following pages are of considerable interest, and show that from such sewage as we have experimented with, it is probable as much material of value can be recovered in this way as by the activated sludge process.

Study of the Manner and Time of Passage of Sewage through Sedimentation and Activated Sludge Tanks. — A short chapter is also given on this special subject in the continuation of the work described in the report for 1917. It is of great import in sewage treatment.

Filtration of Sewage. — Further studies regarding the important subject of the efficiency of trickling filters of different depths, of the operation of contact filters, and the results of the operation of three sand filters that have been receiving sewage at Lawrence for approximately thirty years, are summarized later.

Stabilizing Sludge with Filter Effluents. — Further work was done on the treatment and stabilization of crude sewage sludge in tanks through which sewage effluents rich in nitrates were passed. This work showed considerable promise, and indicates at least one way in which sludge at filter areas can be prevented from becoming a nuisance, and perhaps made of greater value from a fertilizer point of view.

Studies of Trade Wastes. — Much work was done as usual during the year in regard to the results obtained by the operation of filters, etc., treating liquid trade wastes at many industrial plants in the State. New and special investigations relating to the proper methods of disposal of such wastes and prevention of nuisances were also made.

Studies of Water. — The studies concerning the treatment of water included further investigations regarding the removal of color, investigations on the sterilization by ultra violet ray lamps of a new type, and on the use of chloramine, so called, etc., as shown on following pages.

Much work was done during the year studying the results of the Lawrence city filters and methods for their reconstruction and improvement; also a large amount of work was done regarding the treatment of the water supply of Beverly and Salem by filtration and liquid chlorine.

The personnel of the Division at the end of the year was as follows: —

Director of Division and Chief Chemist.

H. W. Clark.

Principal Assistant Chemists.

Fred B. Forbes (State House Laboratories).
George O. Adams (Lawrence Experiment Station).

Assistant Chemists and Bacteriologists.

State House Laboratories: —
Arthur R. G. Booth.
Lester W. Stickney.
Henry H. Andersen.
Guy G. Russell.

Lawrence Experiment Station: —
James H. Spurr.
William J. Magee.

Laboratory Assistants.

GEORGE H. TWOMBLY (State House Laboratories).
ALFRED H. LINDROTH (State House Laboratories).
GEORGE E. PARKHURST (Lawrence Experiment Station).

Stenographer.

ISABELLE J. PRATT.

Clerk.

ANNIE E. HOLTON.

Filter Attendant.

PATRICK KEEGAN.

The following men from this Division were in the service during the year: —

Ernest F. Bower.
Joseph A. McCarthy.
Allen M. Symonds.
Walter D. Lowell.

INVESTIGATIONS UPON THE PURIFICATION OF SEWAGE AND WATER AT THE LAWRENCE EXPERIMENT STATION DURING THE YEAR 1918.

Character of the Sewage used in the Experiments.

Since September, 1915, sewage has been pumped through a pipe from the Osgood Street sewer, so called, on the south side of the Merrimack River at a point above the entrance of any trade wastes. It is a strong domestic sewage, and was much stronger during 1918 than for several years past.

In this report "regular sewage," so called, is the average of samples collected four times each day of the sewage as it reaches the experiment station; "settled sewage" is the same sewage settled for at least two hours in cylindrical tanks; "sewage applied to Filters Nos. 1, 4 and 9A" is the average of daily samples of all sewages applied to the large intermittent sand filters situated out of doors.

Average analyses of these sewages for the year are shown in the following tables.

Preliminary Treatments of Sewage and Studies of Sludge.

Much attention was given during the year to a study of the collection of sludge and fats by sedimentation and by acidification, and to the recovery of sediment from trickling filter effluents and from an activated sludge tank.

Average Analyses.

Regular Station Sewage.

[Parts in 100,000.]

Ammonia.			Kjeldahl Nitrogen.		Chlorine.	Oxygen consumed.	Bacteria per Cubic Centimeter.
Free.	Albuminoid.						
	Total.	In Solution.	Total.	In Solution.			
5.48	1.01	.60	1.62	1.11	10.67	6.55	3,100,000
Settled Station Sewage.							
5.19	0.78	.46	1.46	0.90	9.00	5.05	2,420,000
Sewage applied to Filters Nos. 1, 4 and 9A.							
5.49	0.77	-	1.54	-	10.25	5.52	-

Average Solids.

Regular Station Sewage.

[Parts in 100,000.]

Unfiltered.			Filtered.			In Suspension.		
Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.
70.6	33.7	36.9	50.0	19.0	31.0	20.6	14.7	5.9
Settled Station Sewage.								
56.9	24.5	32.4	42.4	15.4	27.0	14.5	9.1	5.4

Collection of Sludge from Sewage by Plain Sedimentation and by Acidification with SO_2 and Sedimentation.

In further work upon the recovery of sludge, parallel tests were made in regard to the collection of sludge by plain sedimentation and by sedimentation after acidification of the sewage by SO_2, about 160 gallons of sewage being used daily for each test. The tanks used were 3 feet deep, and four hours for sedimentation were allowed. After

settling, the supernatant sewage was drawn off daily and the sludge removed once each week. Sedimentation was not interfered with by fermentation during this period.

SO_2 was generated by burning sulphur and the resulting gases blown through the sewage, the SO_2 readily dissolving. The average alkalinity of the sewage used was equivalent to 27.6 parts calcium carbonate in 100,000, and the excess acidity was kept at about 10 per cent, the average being equivalent to 2.7 parts calcium carbonate.

The amount of SO_2 added was equivalent to 3,088 pounds per million gallons of sewage, and was calculated from the alkalinity of the sewage and the excess acidity after treatment, assuming that all the alkalinity of the sewage is converted to the bisulphite. This assumption is based on the facts that neither the sulphite nor bisulphite is acid to methyl orange, and when SO_2 is added to a dilute solution of a sulphite, no acidity is reached until all the sulphite is converted to bisulphite.

Samples of the freshly acidified sewage were titrated with iodine solution according to the following reactions: —

$$CaSO_3+I_2+H_2O=CaSO_4+2HI$$
$$CaH_2(SO_3)_2+2H_2O+2I_2=CaH_2(SO_4)_2+4HI$$

The calcium acid sulphate is unstable, breaking up into sulphuric acid and the normal sulphate. If sodium were the base the effect would be the same, as sodium acid sulphate is acid to the full extent of its combining power. In other words, if only neutral sulphite is present in the treated sewage, each molecule of sodium sulphite when titrated with iodine liberates acid equivalent to two molecules of sodium hydrate, but when the bisulphite is titrated the acid liberated is equivalent to three molecules of sodium hydrate. The amounts of acid actually found showed that practically all the alkalinity of the sewage had been converted to the bisulphite. The bisulphite oxidizes quite readily to the bisulphate, so that titrations of the excess acidity must be made promptly.

In the tables following the figures in regard to the amount of fats found are the average of the amounts obtained from each week's run, and not those derived from the average weight of sludge and the average per cent of fats.

Average analyses of the regular sewage used in the experiments, of the supernatant sewages after settling and of the sludges are shown in the following tables. Sludge is considered as consisting wholly of suspended solids, excluding the dissolved solids.

Sludge from Sedimentation and Acid Treatment of Sewage.

Sludge from —	Average Pounds per Million Gallons of Sewage.		Per Cent Nitrogen.	Per Cent Fats.	Per Cent Organic Matter.
	Dry Sludge.	Fats.			
Plain sedimentation, ...	1,504	262	3.36	18.1	64.0
Acid treatment, ...	1,983	420	3.92	21.0	73.8
Suspended solids in raw sewage, . .	1,875	-	-	-	67.2

As shown by the table, acid treatment gave an increase, above the amounts obtained from sedimentation, of 479 pounds of sludge per million gallons of sewage, or 32 per cent, while the fats were increased 158 pounds, or 60 per cent.

Regular Sewage.

[Parts in 100,000.]

Ammonia.			Kjeldahl Nitrogen.		Chlorine.	Oxygen consumed.	Alkalinity.
Free.	Albuminoid. Total.	Albuminoid. In Solution.	Total.	In Solution.			
6.25	1.02	.60	1.89	1.16	10.5	6.15	27.6

Supernatant Sewage from Plain Settling.

6.27	0.75	.50	1.33	0.97	-	4.43	-

Supernatant Sewage from Acid Treatment.

5.34	0.50	.38	1.60[1]	1.25[1]	-	-	—2.7

[1] These Kjeldahl values are undoubtedly high, and seem to be due to some combination of the free ammonia and the SO_2 that is not decomposed by alkali.

The bacteria, both those growing at 20° C. and at 37° C., were reduced 97 per cent by the SO_2 treatment. The reduction by plain settling was not determined, but from results of other settling tanks it was probably not over 15 per cent.

Acidification with Sulphuric Acid.

In further work along these lines, from Sept. 24 to Nov. 30, 1918, sulphuric acid was substituted for SO_2 in the acid treatment, but did not appear to be quite so efficient as the SO_2, although the results were not directly comparable. The sludge collected during the last part of the year was considerably higher in organic matter than that collected while SO_2 was used. The amount of acid used was equivalent to 2,344 pounds 100 per cent acid per million gallons of sewage treated.

SO_2 increased the yield of dry sludge 32 per cent, and of fats 60 per cent, over plain sedimentation; sulphuric acid increased the yield of dry sludge 22 per cent, and of fats 28 per cent, over plain sedimentation during the period it was used. The reduction of bacteria was not so good as when SO_2 was used, the average being about 85 per cent for both those growing at 20° C. and at 37° C., while the reduction by SO_2 was 97 per cent. The value of the greater bactericidal action of SO_2 is counterbalanced by the fact that the SO_2 and bisulphites in sewages treated with SO_2 absorb large amounts of dissolved oxygen from water into which such sewage is discharged.

It is doubtful if the increased amounts of sludge and fats resulting from acidification warrant the cost of such treatment. Sewage grease has been found to be of little value for soapmaking on account of the large proportion of unsaponifiable matter, although the increased yield of fats from acid treatment, resulting as it does from the decomposition of soaps, would also probably give an increased proportion of saponifiable fats.

Average Analyses.

Sludge from Plain Sedimentation and from Treatment of Sewage with Sulphuric Acid.[1]

Sludge from —	Average Pounds per Million Gallons of Sewage.		Per Cent Nitrogen.	Per Cent Fats.	Per Cent Organic Matter.
	Dry Sludge.	Fats.			
Plain sedimentation,	935	214	4.80	21.6	76.4
Sulphuric acid treatment,	1,144	274	4.53	24.0	79.0
Suspended solids in raw sewage,	1,497	-	-	-	80.5

[1] From Sept. 24 to Nov. 30, 1918.

Average Analyses.

Regular Station Sewage.[1]

[Parts in 100,000.]

Ammonia.			Kjeldahl Nitrogen.		Chlorine.	Oxygen consumed.	Alkalinity.
	Albuminoid.						
Free.	Total.	In Solution.	Total.	In Solution.			
6.03	1.06	.58	1.78	1.15	9.1	5.30	26.4
Supernatant Sewage from Plain Settling.							
5.76	0.66	.49	1.25	1.01	-	3.93	-
Supernatant Sewage from Sulphuric Acid Treatment.							
4.98	0.51	.41	1.29	1.00	-	-	—2.3

[1] From Sept. 24 to Nov. 30, 1918.

Purification of Sewage by Aeration. — Activated Sludge.

Activated sludge Tank No. 485 was started on April 10, 1917, and has since been operated on the continuous-flow plan. It consists of three compartments, or sections, made of 30-inch Akron pipe set in concrete bases, and each section is about 75 inches deep over a conical bottom, and has a capacity of 230 gallons, or a total tank capacity of 690 gallons. The first two sections are each divided across the middle into two compartments by wooden baffles 6 feet deep. The overflow from the last section is piped to a square, concrete cased, iron, sloped bottom settling tank, 92 inches deep, with a capacity of 600 gallons. The overflow of this settling tank is passed upward through a tank 10 feet deep, holding 160 gallons. During the year the average suspended solids in this final effluent were 2.7 parts in 100,000.

Sludge from the settling tanks is drawn at intervals of an hour or so into a 200-gallon iron, sludge storage tank, where it is aerated with the same proportion of air as is used in the main tank. During the first six months of the year this sludge was pumped back to the first section twice a day, and later three times a day. The average theoretical time of retention of sewage in the tank was 5.38 hours, and the average time of active operation, that is, while sewage was being applied, was

fifteen hours daily. The amount of air applied was 1.78 cubic feet per gallon of sewage until May 1, when it was gradually increased to 2.80 cubic feet, the average being 2.32 cubic feet per gallon of sewage. This air was applied through perforated, hollow, circular brass discs placed in the bottom of each section of the tank.

The dissolved oxygen in the sewage of each of the three sections varied from 0 to 60 per cent of saturation, the average for each being 14, 21 and 22 per cent, respectively. Eighty-three per cent of the samples of effluent tested were stable on incubation. Practically all of the unstable samples were collected early in the year when the air supply was insufficient. The nitrates in the effluent contained oxygen derived from the dissolved oxygen, the average being equivalent to 0.87 part dissolved oxygen.

During the year certain experiments were made in regard to the maintenance of aerobic conditions in the tank by the use of sodium nitrate; that is to say, during nights, when the air supply was discontinued, enough of this salt was added to the sewage in each section of the tank to saturate at least twice with dissolved oxygen the entire contents of the tank. Careful tests were made, showing that the amount of nitrates added was always consumed, and hence no nitrates from this source appeared in the effluent.

It was intended to keep the volume of activated sludge used equal to about 20 per cent of the total volume of the tank, and on seventeen occasions surplus sludge was pumped to waste. The amount of sludge so wasted, that might have been recovered as fertilizing material, was equivalent to 770 pounds of dry sludge per million gallons of sewage passed through the tank, and it contained 6.15 per cent nitrogen and 5 per cent fats. The effluent from the tank was of much better quality during the last six months than during its earlier operation, this being due to the greater volume of air used, more frequent withdrawals of surplus sludge and to better aeration of the sludge.

Filtration of the Effluent from an Activated Sludge Tank through Sand.

Filter No. 495, $\frac{1}{10000}$ of an acre in area, containing 5 feet in depth of sand with an effective size of .25 millimeter, was started on March 18, 1918. It received the effluent from activated sludge Tank No. 485 at a rate of 100,000 gallons per acre daily. The effluent was clear and well nitrified, but the color and albuminoid ammonia were somewhat higher than would have been expected from an applied sewage that had had such a good preliminary treatment.

Average Analyses.

Regular Station Sewage applied to Activated Sludge Tank No. 485.

[Parts in 100,000.]

Appearance.		Ammonia.			Kjeldahl Nitrogen.			Nitrogen as —				
			Albuminoid.									
Turbidity.	Color.	Free.	Total.	In Solution.	Total.	In Solution.	Chlorine.	Nitrates.	Nitrites.	Oxygen consumed.	Alkalinity.	Bacteria per Cubic Centimeter.
-	-	5.22	.75	.48	1.65	1.02	9.72	-	-	6.20	-	3,100,000
Effluent from Activated Sludge Tank No. 485.												
0.5	.67	3.37	.26	.19	.58	.37	10.02	.19	.0824	1.58	20.3	660,000
Effluent from Filter No. 495.												
0.0	.32	0.51	.06	-	-	-	10.68	2.80	.0146	0.55	2.6	10,000

Average Solids.

Regular Station Sewage applied to Activated Sludge Tank No. 485.

[Parts in 100,000.]

Unfiltered.			Filtered.			In Suspension.		
Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.
71.4	33.7	37.7	49.4	19.8	29.6	22.0	13.9	8.1
Effluent from Activated Sludge Tank No. 485.								
44.8	13.1	31.7	42.1	11.2	30.9	2.7	1.9	0.8

Volume of Air required for Efficient Agitation.

Experiments have been made during the year with Tank No. 485 in regard to the amount of sludge which will be well agitated and held in suspension in the sewage by different volumes of air expressed in cubic feet of air per hour per million gallons of sewage aerated. The results given in the following table show that in this tank, 9 feet in depth, at

least 100,000 cubic feet per hour per million gallons are needed. In the table the amount of matter held in suspension in the sewage agitated by these different volumes of air is shown by the volume settling at different times in liter cylinders of sewage collected from the activated sludge tank.

Amount of Air applied (Cubic Feet).	Per Cent of Sludge by Volume after settling —			
	15 Minutes.	30 Minutes.	1 Hour.	12 Hours.
50,000,	17.7	14.6	12.1	9.9
100,000,	30.8	24.6	21.0	13.8
200,000,	31.0	25.0	21.0	13.9
300,000,	32.0	24.5	21.0	14.0

Activated Sludge Experiments in Regard to the Effect of Varying Volumes of Sludge.

On March 18 an experiment was started to study the effect on the activated sludge process of the use of different volumes of sludge. Gallon bottles were used as miniature activated sludge tanks operated on the fill and draw plan, with one filling daily, a three-hour period of aeration and one and one-half hours' settling before withdrawal of the treated sewage. The sludge was aerated practically continuously.

Activated sludge from Tank No. 485, containing 4.7 per cent total suspended solids, was used to start the experiment, and 10, 20 and 30 per cent, respectively, of the total capacity of each bottle was filled with the sludge. At first, air was applied at the rate of 25 gallons per hour per gallon of sewage; but after the expiration of three weeks, only one-third of this volume of air was used. As the sludge in the bottles accumulated, the surplus was removed. In each case the treated sewage contained very little dissolved oxygen, but was always stable and clear, with a certain amount of light-colored, slow-settling suspended matter present. The average amount of suspended matter in the three effluents was 3.5, 2.2 and 2.0 parts in 100,000, respectively. These effluents were of practically equal quality, only slightly greater efficiency being given by the use of the larger amounts of sludge. The most noticeable differences were in the amounts of surplus sludge collected in each bottle, and in the nitrogen content of the different sludges, the amount of surplus sludge collected varying directly, and the nitrogen content varying inversely, as the amount of sludge maintained in the tank.

Average Analyses of Applied Sewage and Effluents.

[Parts in 100,000.]

	Ammonia.			Nitrogen as —		Oxygen consumed.
	Free.	Albuminoid.				
		Total.	In Solution.	Nitrates.	Nitrites.	
Applied sewage,	6.50	.90	.49	-	-	5.60
Effluent from: —						
10 per cent sludge bottle,	4.06	.23	.16	.50	.1080	1.38
20 per cent sludge bottle,	3.93	.20	.14	.84	.0240	1.03
30 per cent sludge bottle,	3.65	.17	.15	.77	.0300	1.06

Average Analyses of Sludge removed from Bottles.

Per Cent.	Bottle No. 1, 10 Per Cent Sludge.	Bottle No. 2, 20 Per Cent Sludge.	Bottle No. 3, 30 Per Cent Sludge.
Nitrogen,	5.20	4.71	4.29
Fats,	3.00	1.90	2.10
Loss on ignition,	57.90	59.90	53.20

The total suspended solids in the sewage used in these experiments were equal to 2,291 pounds per million gallons, and the organic suspended solids were equal to 1,399 pounds.

The surplus total suspended solids from the bottles containing 10, 20 and 30 per cent sludge, expressed in pounds per million gallons of sewage applied, were 2,108, 2,343 and 2,414, respectively, and the organic matter in the sludge, 961, 822 and 1,191 pounds, respectively.

Stabilizing Sewage Sludge by Oxidation with Nitrates from Sewage Filter Effluents.

This investigation in regard to the treatment of sludge to destroy its offensive properties and render its disposal at certain municipal filtration areas free from all but slight odors was continued during the year. The work was carried on with Tank No. 483, which is made of Akron pipe set in concrete, consisting of three compartments, 4 feet deep, connected in series, each with a capacity of about 65 gallons. Sewage sludge was passed into these compartments in rotation, and a maximum storage of three months was given. The inlets and overflows of the

tank are so arranged that the effluents applied passed through all three compartments, entering at the bottom and leaving about 6 inches below the surface of each.

The greater part of the effluent used came from trickling filters, although some contact filter effluents were also applied. The volume applied daily averaged 1.10 volumes of effluent for each volume of sludge containing 5 per cent of solids in the three compartments; that is, each gallon of sludge was treated with about 100 gallons of effluent. Forty-three per cent of the samples of overflow were stable, and the solids in suspension were 7.3 parts in 100,000.

The sludge after four weeks' tank treatment was always inoffensive, and almost invariably remained so when removed from the tank. During this process the sludge lost nitrogen and organic matter; the fats were oxidized as in the activated sludge process, but in the activated sludge tank there was a constant addition of coagulated colloidal matter, high in nitrogen and organic matter and low in fats.

Average analyses of the applied filter effluent, of the overflow from the last compartment, and sludge analyses on a dry basis are shown in the following tables: —

Effluent applied to Tank No. 483.

[Parts in 100,000.]

Ammonia.			Kjeldahl Nitrogen.	Nitrogen as —		Oxygen consumed.
Free.	Albuminoid.					
	Total.	In Solution.		Nitrates.	Nitrites.	
3.00	.45	.26	.81	2.16	.1255	2.76
Overflow from Tank No. 483.						
3.51	.35	.25	.64	0.41	.0940	2.38

Sludge Analyses.

Sludge from —	Per Cent on Dry Basis of —		
	Fats.	Nitrogen.	Loss on Ignition.
Activated Sludge Tank No. 485,	5.0	6.15	64.7
Settling tank applied to Tank No. 483,	18.1	2.61	56.9
Tank No. 483: —			
After 4 weeks,	10.9	2.10	43.6
After 8 weeks,	8.8	2.13	44.4
After 12 weeks,	8.7	1.93	41.0

Experiments upon the Recovery of Sediment from Trickling Filter Effluents.

On account of the interest attached to the recovery of fertilizing materials from sewage and treated sewage, some sedimentation experiments were made to determine the proportions of the sediment that can be recovered from trickling filter effluents. In this work, at first the combined effluents from three trickling filters, Nos. 453, 454 and 474, were run into a circular tank, 5 feet deep and 20 inches in diameter, and samples collected midway of the tank after two hours' settling. The average suspended solids in the combined effluents during the six months of the experiment were 19.9 parts in 100,000, and after settling, 2.9 parts, — a reduction of 86 per cent.

In another experiment lasting three months the effluent from Filter No. 452 was settled in a tank 27 inches deep. The suspended solids before settling were 23.4 parts in 100,000, and after settling, 0.8 part, — a reduction of 97 per cent. In this case the high reduction was probably partly due to coagulation taking place during the sedimentation, as the soluble albuminoid ammonia was reduced from .25 to .17 part in 100,000 during the two hours' sedimentation.

The following table indicates the amount of settleable matter in the effluents from all the trickling filters at the station, and the amount of sludge recovered from activated sludge Tank No. 485.

Average Suspended Solids in Trickling Filter Effluents, etc.

Suspended Solids in Effluent from —	Pounds per Million Gallons.
Filter No. 135,	758
Filter No. 452,	825
Filter No. 453,	971
Filter No. 454,	733
Filter No. 455,	704
Filter No. 472,	708
Filter No. 473,	675
Filter No. 474,	683
Filter No. 475,	933
Settled sewage applied to filters above,	1,205
Regular sewage applied to activated sludge Tank No. 485,	1,608
Surplus sludge removed from Tank No. 485,	770

The average amount of settleable suspended matter in the effluents from trickling filters was 777 pounds per million gallons, or 64 per cent of the amount found in the sewage applied; the total suspended matter in the sludge removed from activated sludge Tank No. 485 averaged 770 pounds per million gallons, or 48 per cent of that in the sewage applied.

Aeration of a Somewhat Poor Trickling Filter Effluent with Activated Sludge.

A portion of the effluent from trickling filter No. 452, containing 4 feet in depth of broken stone, and operated at the rate of 1,500,000 gallons per acre daily, was treated in a small activated sludge tank, 20 inches in diameter and 36 inches deep, during a period of several months. The sludge was the sediment collected from trickling filter effluents, activated by a few days' aeration. Air was applied at a rate of about 1.25 cubic feet per gallon of effluent treated.

The results from this treatment appeared to be abnormally good, and there seemed to have been coagulation and precipitation, as the soluble albuminoid ammonia was decidedly reduced. All samples of the raw, settled and aerated effluent were stable except one at the immediate start of the experiment.

Average analyses are shown in the following table: —

Average Analyses.

Effluent from Trickling Filter No. 452 before Aeration with Activated Sludge.

[Parts in 100,000.]

Appearance.			Ammonia.			Nitrogen as —		Oxygen consumed.	Total Suspended Solids.
			Free.	Albuminoid.					
Turbidity.	Sediment.	Color.		Total.	In Solution.	Nitrates.	Nitrites.		
0.9	8.4	.71	2.32	.46	.21	.54	.1163	3.21	20.8
Effluent from Trickling Filter No. 452 after Aeration with Activated Sludge.									
0.3	0.5	.60	1.80	.14	.11	.78	.0965	1.02	0.8

Operation of Trickling Filters.

During the year nine trickling filters receiving sewage clarified by sedimentation were operated. One of these filters, No. 135, has now been in operation for nineteen years, — a longer time, without doubt,

than any other trickling filter, either experimental or municipal, in America. It contains 10 feet in depth of pieces of fine broken stone having an average volume of .52 cubic centimeter. All of this stone passes a 1-inch screen, but is retained by a ¼-inch screen. In spite of the fineness of this material it has been necessary to dig over the filter surface to a depth of from 3 to 8 inches only eight times up to April, 1918. At that time the open space of the upper foot of stone was found to be completely filled with sludge, and 18 inches in depth were removed, washed and replaced. The remainder of the filter was then flushed out with water equivalent to 1,000,000 gallons per acre applied in fifteen minutes. The dry sludge washed from the upper 18 inches of stone was equal to 1.84 pounds per cubic foot of material, while the amount flushed from the lower 8½ feet of the filter was equal to .03 pound per cubic foot. Measurements of the sludge stored in the filter showed that there has been little increase since 1906, when similar measurements were made.

The Depth of Filtering Material and Trickling Filter Efficiency.

It has been shown and illustrated by diagrams, and explained in previous reports, that filters of considerable depth are more economical and efficient than shallower filters. To illustrate this point, four filters, Nos. 452 to 455, inclusive, were put into operation in 1913, and were continued through the year. These filters are 4, 6, 8 and 10 feet in depth, respectively, and are constructed of broken stone that will pass a 1½-inch screen and be retained by a ¾-inch screen. Certain experiments made during the year with these filters are not recorded here, but a table beyond shows the rates that could be followed with equal purification results.

A similar series of filters, Nos. 472 to 475, inclusive, was started in 1915. In this second series the broken stone is of a much larger grade than that in the first, the average volume of the pieces ranging from 25.2 to 29.4 cubic centimeters. These filters were also operated at such rates that the effluents were of approximately the same quality. The coarse material of these filters has only about one-half as much surface per foot in depth of filter as the finer material in Filters Nos. 452 to 455, inclusive, and sewage passes through the filters in a correspondingly shorter time, giving a lower purification at a given rate.

Average Rates and Results. — Trickling Filters.

Filter Number.	Depth (Feet).	Gallons filtered per Acre Daily per Foot of Filter Depth.		Per Cent of Samples Stable.	
		During 1912.	Since Filter was started.	During 1912.	Since Filter was started.
452,	4	50,000	92,000	100	87
453,	6	78,000	115,000	100	92
454,	8	116,000	192,000	100	98
455,	10	203,000	348,000	100	84
472,	4	86,000	84,000	68	49
473,	6	83,000	108,000	90	75
474,	8	114,000	117,000	90	83
475,	10	116,000	142,000	85	87

Average Analyses.

Effluents from Trickling Filters Nos. 135, 452, 453, 454, 455, 472, 473, 474 and 475.

[Parts in 100,000.]

Filter Number.	Quantity applied. — Gallons per Acre Daily.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Kjeldahl Nitrogen.	Chlorine.	Nitrogen as — Nitrates.	Nitrogen as — Nitrites.	Oxygen consumed.	Alkalinity.	Bacteria per Cubic Centimeter.
135,	1,320,000	3.0540	.4233	.2610	.78	8.86	1.75	.0642	2.62	13.1	580,000
452,	204,000	3.4250	.5012	.3240	.88	7.82	2.51	.0510	2.35	10.6	330,000
453,	468,000	4.0420	.4552	.3330	.81	7.80	2.01	.0432	2.55	12.4	400,000
454,	931,000	3.2320	.3532	.2542	.63	7.92	1.89	.0632	2.16	11.7	180,000
455,	2,034,000	4.2420	.3660	.2810	.66	7.50	.85	.0540	2.18	15.9	340,000
472,	344,000	2.8950	.4383	.2827	.81	9.12	1.39	.1301	2.69	13.0	640,000
473,	500,000	3.1570	.4254	.2855	.73	8.99	1.77	.0654	2.49	13.3	620,000
474,	916,000	2.9630	.4215	.2797	.79	8.83	1.40	.1620	2.58	12.9	1,120,000
475,	1,163,000	3.0170	.4200	.2516	.83	8.83	1.68	.0646	2.78	12.4	860,000

Average Solids.

Effluents from Filters Nos. 135, 452, 453, 454, 455, 472, 473, 474 and 475.

[Parts in 100,000.]

Filter Number.	Unfiltered.			Filtered.			In Suspension.		
	Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.
135, . . .	55.6	21.9	33.7	46.5	16.9	29.6	9.1	5.0	4.1
452, . . .	54.5	22.8	31.7	47.8	19.5	28.3	6.7	3.3	3.4
453, . . .	54.1	23.1	31.0	44.3	17.0	27.3	9.8	6.1	3.7
454, . . .	48.0	18.9	29.1	43.8	17.0	26.8	4.2	1.9	2.3
455, . . .	40.2	14.4	25.8	37.5	13.5	24.0	2.7	0.9	1.8
472, . . .	54.0	20.3	33.7	45.5	15.7	29.8	8.5	4.6	3.9
473, . . .	55.5	22.2	33.3	47.4	17.2	30.2	8.1	5.0	3.1
474, . . .	52.9	20.7	32.2	44.7	15.9	28.8	8.2	4.8	3.4
475, . . .	56.6	22.9	33.7	45.4	17.2	28.2	11.2	5.7	5.5

Operation of Contact Filters.

Contact filters at the station are operated largely to study their permanency and to demonstrate to students, engineers, sewerage commissioners, etc., the construction, method of operation and results obtainable with such filters. Three were operated during the year.

Filter No. 175 has been in operation since 1901, a period of seventeen years, and is constructed of 4 feet in depth of coke of such size that all will pass a 1-inch screen, 75 per cent a ½-inch screen and practically none a ¼-inch screen. At the end of 1911, owing to clogging, it was necessary to remove and wash all of the filter material. For sixteen years the filter received sewage that had been screened through fine coke or coal, but for the last two years it has received settled sewage. It is flooded once daily, stands full two hours before draining, and is allowed to rest every sixth week. Seventy-nine per cent of the samples of effluent were stable. At the end of the year the loss of open space was 50 per cent, an increase during the year of 7 per cent.

Filter No. 425 was put into operation in January, 1911, and is constructed of 33 inches in depth of soft coal clinker having a diameter between ¼ inch and 1¼ inches. It is filled twice daily, stands full one hour before draining, and allowed to rest every sixth week. The loss of open space at the end of the year was 58 per cent, an increase of 6 per cent during the year.

Double Contact Filtration.

Filter No. 443, constructed of 21 inches in depth of broken stone pebbles all of which will pass a ½-inch screen, 43 per cent a ¼-inch screen and practically none a ⅛-inch screen, was started in April, 1912, and has been operated twice daily as a secondary contact filter receiving the effluent from Filter No. 425, and allowed to rest every sixth week. All samples of the effluent were stable. The loss of open space at the end of the year was 58 per cent, an increase of 18 per cent.

Average Analyses.

Effluent from Filter No. 175.

[Parts in 100,000.]

Quantity applied. — Gallons per Acre.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Kjeldahl Nitrogen.	Chlorine.	Nitrogen as — Nitrates.	Nitrogen as — Nitrites.	Oxygen consumed.	Alkalinity.	Bacteria per Cubic Centimeter.
363,000	2.0150	.3246	.2320	.66	9.43	1.04	.0973	2.48	12.0	1,330,000
Effluent from Filter No. 425.										
358,000	1.5510	.4930	.2518	.88	9.21	1.57	.1048	2.99	8.8	840,000
Effluent from Filter No. 443.										
357,000	1.0300	.2788	.1683	.57	8.97	2.17	.0943	2.06	5.2	1,080,000

Average Solids.

Effluent from Filter No. 175.

[Parts in 100,000.]

Unfiltered. Total.	Unfiltered. Loss on Ignition.	Unfiltered. Fixed.	Filtered. Total.	Filtered. Loss on Ignition.	Filtered. Fixed.	In Suspension. Total.	In Suspension. Loss on Ignition.	In Suspension. Fixed.
48.9	16.4	32.5	43.6	13.1	30.5	5.3	3.3	2.0
Effluent from Filter No. 425.								
63.2	24.7	38.5	46.4	14.7	31.7	16.8	10.0	6.8

Average Solids — Concluded.

Effluent from Filter No. 443.

[Parts in 100,000.]

Unfiltered.			Filtered.			In Suspension.		
Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.
58.8	22.6	36.2	53.3	19.1	34.2	5.5	3.5	2.0

Intermittent Sand Filters operated with Untreated Sewage. — Filters Nos. 1, 4 and 9A.

Each of these three sand filters is $\frac{1}{200}$ of an acre in area, and at the end of the year Filters Nos. 1 and 4 had been operated continuously for nearly thirty-one years, and Filter No. 9A had been operated twenty-eight years. These filters are probably the oldest regularly operated sewage filters in this country, and are kept in operation to demonstrate the permanency of such filters when properly cared for. Regular station sewage without preliminary clarification has always been applied to them, and for many years it has been the practice to apply only as much sewage to each filter as can be purified without materially increasing the amount of organic matter stored within the filter. Since 1893, a period of about twenty-five years, each of these filters has been operated without the removal of any surface sand.

The depth and size of sand of which each filter is constructed, the date when first put into operation, the total volume of sewage treated upon each filter since it was started, and the volume of sewage applied daily during the year are shown in the following table: —

Filter Number.	Depth (Feet).	Effective Size of Sand (Millimeter).	Date first operated.	Actual Volume of Sewage applied since Start (Gallons.)	Volume of Sewage applied daily during 1918 (Gallons per Acre).
1, ...	5	.48	Dec. 10, 1888	3,028,600	44,100
4, ...	5	.04	Dec. 19, 1887	1,056,090	19,400
9A, ...	5	.17	Nov. 18, 1890	2,516,530	44,000

For a number of years the surface of Filters Nos. 1 and 9A have been leveled during the summer, but have been trenched and ridged

during the winter. The surface of Filter No. 4 is arranged in circular trenches, 14 inches wide, which are filled to a depth of 12 inches with sand of an effective size of .48 millimeter. The sewage is applied to these trenches, grass being permitted to grow on the ridges. During the year the surface of the filters was dug over twice to a depth of from 8 to 10 inches, and raked to a depth of 2 inches on twelve, seventeen and fifteen different occasions, respectively. Board coverings were put over the trenches on December 5 and removed on March 28.

An examination of the sands in Filters Nos. 1 and 9A is made about the 1st of July each year. As has been previously stated, the greater part of the stored organic matter is in the first foot of sand, and a following table shows analyses for the past ten years. There was a certain accumulation during the year due to the application of sewage stronger than usual.

The average analyses of the effluents from these filters are shown in the following tables: —

Average Analyses.

Effluent from Filter No. 1.

[Parts in 100,000.]

Temperature (Degrees F.).		Ammonia.		Chlorine.	Nitrogen as —		Oxygen consumed.	Alkalinity.	Bacteria per Cubic Centimeter.
Applied.	Effluent.	Free.	Total Albuminoid.		Nitrates.	Nitrites.			
59	51	1.2680	.0760	9.53	4.08	.0062	.76	—0.7	5,900

Effluent from Filter No. 4.

60	51	0.3613	.0334	8.52	3.87	.0366	.46	—1.2	310

Effluent from Filter No. 9A.

57	53	1.1106	.0704	7.98	3.80	.0028	.82	—0.3	3,300

Sand Analyses.

Albuminoid Ammonia in First Foot of Sand in Filters Nos. 1 and 9A.

[Parts in 100,000.]

Year.	Filter No. 1.	Filter No. 9A.
1909,	52.7	69.3
1910,	66.1	56.5
1911,	45.6	65.1
1912,	74.0	83.9
1913,	77.3	74.8
1914,	95.2	76.0
1915,	74.9	81.1
1916,	80.8	70.0
1917,	83.0	79.2
1918,	106.0	86.3

Flow of Sewage through Sedimentation and Activated Sludge Tanks.

During 1918 an investigation in regard to the method of flow of liquids through sedimentation and activated sludge tanks was continued, this study having been begun during 1917. Not as much was accomplished along this line as could be desired, owing to the limited time that could be given to it.

Two experiments were made in the first place in regard to the passage of sewage through the wooden tank, 31 feet long, 31 inches wide and 30 inches deep, mentioned in the previous report, and in which fourteen baffles were placed for this experimental work, the sewage going through passing alternately above and below each baffle through openings 6 inches high and of the width of the tank, namely, 31 inches.

As in the tests discussed last year, a certain amount of ammonium chloride solution was mixed with the water in the tank and then displaced by canal water entering at the desired rate. In these two experiments theoretical storages of four and six hours were used. The baffles used prevented to a considerable extent the retention and mixture of the passing sewage, and hence shortened in each experiment the actual period of passage, making it more nearly conform to the theoretical period than when the tank was used as a sedimentation tank without baffles, or only with the insertion of one or two, as in previous experiments. With the tank baffled as completely as stated, practically 95 per cent of the sewage passed through in each experiment in the theoretical time; namely, four and six hours.

Further experiments on the passage of sewage through activated sludge tanks, baffled or divided in such a way that they contained from two to five sections, were made. These experiments are being continued, and will be reported on with diagrams in the next annual report.

Treatment and Filtration of Water.

Removal of Color from Water.

Following preliminary experiments, two filters were started in May, 1917, to study the removal of color by sand impregnated with ferric hydrate.

One of these filters, No. 487, was 23½ inches in diameter, and contained 2 feet in depth of sand of an effective size of .34 millimeter. In the sand of this filter nearly 22 tons per acre of ferric sulphate was precipitated by alternate applications of caustic soda and ferric sulphate solutions.

Filter No. 488 is 10 inches in diameter, and contains 4 feet in depth of sand of an effective size of .25 millimeter. In preparing this filter for color removal the same proportion of ferric sulphate was used, but magnesium oxide was mixed with the sand to furnish the alkali to precipitate the iron. Both filters were operated at a rate of 5,000,000 gallons per acre daily, and the results of their operation up to Nov. 1, 1917, are summarized in the report for that year. Filter No. 487 was stopped at that time.

On Jan. 7, 1918, a third filter, No. 494, was started, of the same depth and grade of sand as in Filter No. 488. In the sand of this filter 36 tons per acre of commercial aluminum sulphate was precipitated by alternate applications of aluminum sulphate and soda ash. In discussing the results of Filter No. 488, the period from the start in May, 1917, to Nov. 1, 1918, will be covered.

When filters containing precipitated iron are first started, the color removal is over 90 per cent. Gradually the color-removing properties decrease, until after thirty-five or forty days they will have decreased one-half. The filter is then thoroughly drained, and caustic soda, usually at the rate of 10 tons per acre, — dissolved in just water enough to fill the open space of the sand, — is applied to the filter, and after standing over night drained out. After this treatment, at least three days, at the usual rate of operation, are required to wash out the excess caustic.

The average period between treatments with caustic to dissolve out organic matter has been forty-one days. During 1918 this treatment with caustic had the effect of keeping the surface of the filters clean,

and no scrapings were necessary. Filter No. 494 was operated an average of thirty-nine days between treatments, and no appreciable amount of aluminum hydrate was dissolved by the application of the caustic soda solution.

By this caustic treatment 65 and 48 per cent, respectively, of the coloring matter removed from the water and retained in the sand was removed from Filters Nos. 488 and 494, and 42 and 34 per cent of the albuminoid ammonia and 55 and 45 per cent, respectively, of the organic matter.

On several occasions, after the caustic treatment and before all the caustic was entirely washed out, additional amounts of ferric sulphate or aluminum sulphate were applied to the two filters. The total amount of ferric sulphate applied to Filter No. 488 during the period under discussion was 42.8 tons per acre, equivalent to .24 grain per gallon of water filtered, and the caustic soda used was equivalent to .52 grain per gallon. A total of 41.5 tons per acre of aluminum sulphate was applied to Filter No. 494, equivalent to .59 grain per gallon, and caustic soda equivalent to .64 grain per gallon of water filtered.

The ferric sulphate applied to Filter No. 488 is expressed in terms of 100 per cent material, while the aluminum sulphate applied to Filter No. 494 was the commercial salt containing from 50 to 60 per cent actual aluminum sulphate.

The maximum amount of chemicals that can be added to each filter without reducing the open space of the sand has not been even approached as yet, this being shown clearly by the slight loss of head encountered in the operation of these filters. The caustic treatment is largely responsible for this, as it dissolves the organic matter from the surface of the filter.

Filter No. 488 for some months has given a color reduction of from 50 to 60 per cent. It has been operated sixteen months, and the indications are that this efficiency can be continued many months more. About half of the stored organic matters have been removed by the caustic treatment, but as there is notwithstanding this a constant accumulation of organic matter the time will come when the sand will have to be removed and washed or replaced with new sand.

Filter No. 494 has not been quite as efficient as Filter No. 488, but it contains only about half as much precipitated material. Tables showing results follow: —

Average Analyses.

Canal Water, May, 1917, to November, 1918.

[Parts in 100,000.]

Color.	Ammonia.			Nitrogen as —		Oxygen consumed.	Iron.	Alkalinity.	Soap Hardness.
	Free.	Albuminoid.							
		Total.	In Solution.	Nitrates.	Nitrites.				
.41	.0193	.0214	.0154	.022	.0009	.53	.0497	0.9	1.1
Effluent from Filter No. 488, May, 1917, to November, 1918.									
.15	.0103	.0088	-	.023	.0014	.23	.0131	1.2	1.2
Effluent from Filter No. 494, January, 1918, to November, 1918.									
.16	.0163	.0099	-	.022	.0014	.26	.0177	1.3	1.4

Efficiency of a New Type of Lamp in the Sterilization of Merrimack River Water with Ultra Violet Rays.

In 1915 tests were made at the experiment station on the efficiency of ultra violet rays in sterilizing raw and partly purified Merrimack River water.[1] Since then the R. U. V. Company have made a new type of lamp for which greater efficiency is claimed, and during 1918 tests of this lamp were made at the station, river water being run through the apparatus at the rate of 60 gallons per hour. During each test covering a period of twenty days, samples were collected each hour for five hours beginning when the lamp had been lighted one hour,

The average results of these twenty series with the new lamp are shown in the following table. With a polluted water, such as the Merrimack River water, at least, the new type of lamp appears to be little improvement over the old.

Average Bacterial Analyses.

Lamp.	River Water (Bacteria per Cubic Centimeter).			River Water after Radiation (Bacteria per Cubic Centimeter).			Per Cent of Bacteria removed.		
	20° C.	37° C.		20° C.	37° C.		20° C.	37° C.	
		Total.	Red.		Total.	Red.		Total.	Red.
Old type,	17,000	355	210	370	20	3	98	94	99
New type,	22,000	490	390	290	11	5	99	98	99

[1] Annual report for 1915, p. 421.

Average B. Coli Results.

Lamp.	River Water (Per Cent of Samples containing B. Coli).				River Water after Radiation (Per Cent of Samples containing B. Coli).			
	.001 c. c.	.01 c. c.	0.1 c. c.	1 c. c.	0.1 c. c.	1 c. c.	10 c. c.	100 c. c.
Old type, ...	33.3	55.5	100	100	0	6	56	100
New type, ...	5.0	85.0	100	100	0	13	62	100

The Use of Chloramine in the Treatment of Water.

Chloramine is a name applied to certain aromatic compounds containing the NCl linkage, and in connection with water sterilization is applied to the product that is supposed to result from the reaction of calcium hypochlorite and ammonium hydroxide in dilute solutions at low temperatures. Considerable has been written about its use during the past few years, and results of preliminary experiments at the station were given in the last report.

In further work on the treatment of polluted water in this way, a 60-gallon galvanized storage tank was used, the bleach and ammonia solutions were stored in separate tanks and mixed just before being added to the raw water. The apparatus was so operated that one hour's contact of water and chemicals was always given. Varying amounts of bleach alone, and the same amounts of bleach with one-half as much ammonia, were tried through a series of tests lasting about two months, five samples of the treated water being examined each day, and the results of each series are shown in following tables. The results obtained with bleach and ammonia do not seem to show any great advantage over the use of bleach alone.

The Use of Chloramine in the Disinfection of Swimming Pools.

In continued studies of the efficiency of chloramine, its use in connection with hypochlorite of lime was tried out at the swimming pool of the Lawrence Y. M. C. A. In the first experiments the required amount of ammonia was added to the pool just before the addition of hypochlorite. Applied in this way the ammonia apparently had no effect; afterwards, the bleach was mixed with 8 gallons of water and strained and the ammonia added just before the distribution of this treated water throughout the pool. The amount of bleach regularly used was equivalent to 0.5 part in 1,000,000 available chlorine, and when ammonia was used, 0.25 part in 1,000,000 was added to the bleach. The addition of ammonia under the conditions described was entirely without effect in the reduction of bacteria.

Average Bacterial Analyses.

Raw Water (Bacteria per Cubic Centimeter).			Chemicals added (Parts in 1,000,000).	Water after Treatment (Bacteria per Cubic Centimeter).			Per Cent of Bacteria removed.		
20° C.	37° C.			20° C.	37° C.		20° C.	37° C.	
	Total.	Red.			Total.	Red.		Total.	Red.
4,000	250	80	.25 available chlorine, .	1,100	90	45	73	64	44
2,640	114	64	.25 available chlorine, .125 ammonia.	644	27	10	75	76	84
3,700	600	170	.50 available chlorine, .	48	20	0	98	96	100
5,900	800	150	.50 available chlorine, .25 ammonia.	16	14	0	99	98	100

Average B. Coli Results.

Raw Water (Per Cent of Samples containing B. Coli).				Chemicals added (Parts in 1,000,000).	Water after Treatment (Per Cent of Samples containing B. Coli).		
.001 c. c.	.01 c. c.	0.1 c. c.	1.0 c. c.		0.1 c. c.	1 c. c.	10 c. c.
50	100	100	100	.25 available chlorine, . . .	100	100	100
10	100	100	100	.25 available chlorine, .125 ammonia.	30	72	100
0	60	100	100	.50 available chlorine, . . .	0	0	0
0	60	100	100	.50 available chlorine, .25 ammonia.	0	0	0

Work of Experimental Filter upon the Beverly and Salem Water Supply.

The water supply of Beverly and Salem is taken from Wenham Lake. During the past two years the water in this lake has been added to materially by water taken from the Ipswich River, pumped during that portion of the year when the flow of the river is above a stated volume. Connection by means of a canal and pipe line has been made, and a pumping station installed to pump this water over into Wenham Lake.

On July 1, 1916, an experimental filter, $\frac{1}{207}$ acre in area, was put into operation at the lake. This filter is of wood, concrete lined, 10 feet deep, and contains 5 feet in depth of sand of an effective size of 0.27 millimeter and a uniformity coefficient of 3.3. The filter has been operated uniformly at a rate of 3,000,000 gallons per acre daily. Very many samples, both chemical and bacterial, of the water applied to and of the effluent from this filter have been taken since its installation. It is not thought necessary to give these analyses in detail here,

but averages are given covering a period of practically two and one-half years.

At the pumping station for raising the Ipswich River water to Wenham Lake the water is lifted about 20 feet, and at this station a liquid chlorine apparatus is located. During the year various tests of the efficiency of this apparatus in the treatment of Ipswich River water were made, and the results are shown in a following table, this table giving also the amounts of available chlorine added, in parts in 1,000,000, and the color of the Ipswich River water treated. The Ipswich River water, much of which comes from swamps, is one of the highly colored river waters of the State, and, as will be seen by the table, colors varying from 1.50 to even 2.50, as shown by our color standard, are found. The experimental filter has delivered uniformly a safe, satisfactory water, and has removed about 24 per cent of the color of the applied water. Detailed reports in regard to the work accomplished by the chlorine apparatus and the experimental filter have been made to the Department.

Average Chemical Analyses.

Water applied to Experimental Filter, — August, 1916, to September, 1918, inclusive.

[Parts in 100,000.]

Color.	Ammonia.				Oxygen consumed.	Hardness.	Iron.
	Free.	Albuminoid.					
		Total.	In Solution.	In Suspension.			
.37	.0105	.0224	.0183	.0043	.42	2.2	.035

Effluent from Experimental Filter, — August, 1916, to September, 1918, inclusive.

.28	.0026	.0145	-	-	.28	2.4	.019

Average Bacterial Analyses.

Results of the Experimental Filter at the Salem Pumping Station from July, 1916, to September, 1918, inclusive.

Date.	Number of Days tested.	Lake Water before Filtration.						Lake Water after Filtration.					
		Bacteria per Cubic Centimeter.			Per Cent of Samples containing B. Coli.			Bacteria per Cubic Centimeter.			Per Cent of Samples containing B. Coli.		
		20° C.	37° C. Total.	37° C. Red.	0.1 c. c.	1 c. c.	10 c. c.	20° C.	37° C. Total.	37° C. Red.	0.1 c. c.	1 c. c.	10 c. c.
1916.													
July, . .	2	160	13	4	50	100	100	110	7	0	0	0	0
August, . .	4	200	58	12	0	50	100	53	4	0	0	0	25
September, .	3	70	14	1	0	0	33	320	2	0	0	0	33
October, . .	6	83	11	1	0	17	33	10	2	0	0	0	16
November, .	6	150	14	5	0	17	33	70	6	2	0	16	16
December, .	2	14	7	0	0	0	0	70	13	0	0	0	0
1917.													
January, .	5	100	3	0	0	0	60	64	1	0	0	0	0
February, .	2	140	4	1	0	0	0	26	1	0	0	0	0
March, . .	2	3,900	30	5	0	50	50	50	15	0	0	0	0
April, . .	2	130	30	0	0	0	0	18	10	0	0	0	0
May, . .	2	140	35	1	0	0	50	50	15	0	0	0	50
June, . .	2	190	80	40	0	0	100	50	15	3	0	0	0
July, . .	3	120	43	26	0	66	66	50	12	7	0	33	33
August, . .	2	200	10	2	0	50	50	70	5	0	0	0	0
September, .	1	70	2	0	0	0	100	68	7	4	0	0	50
November, .	3	30	2	1	0	0	0	8	1	0	0	0	0
1918.													
January, .	1	3,300	22	3	0	0	0	150	9	1	0	0	0
February, .	3	13,000	90	8	0	0	66	2,200	40	0	0	0	0
March, . .	3	760	60	7	0	0	33	130	33	0	0	0	0
April, . .	1	2,600	280	0	0	0	0	150	50	0	0	0	0
May, . .	1	42	26	0	0	0	0	12	7	0	0	0	0
June, . .	1	250	25	0	0	0	0	50	7	0	0	0	0
July, . .	1	32	5	0	0	0	0	50	14	0	0	0	0
September, .	2	44	10	0	0	0	50	4	2	0	0	0	0
Average, .	–	1,100	35	5	2	15	38	160	12	7	0	2	9

Average Bacterial Analyses.

Ipswich River Water before and after Treatment with Chlorine, May, 1916, to April, 1918, inclusive.

Date.	Before Treatment with Chlorine.				Chlorine added (Parts in 1,000,000).	After Treatment with Chlorine.			
	Color.	Bacteria per Cubic Centimeter.				Color.	Bacteria per Cubic Centimeter.		
		20° C.	37° C.				20° C.	37° C.	
			Total.	Red.				Total.	Red.
1916.									
May 23,	1.88	220	22	6	0.46	1.85	315	10	2
May 31,	2.23	177	12	3	0.17	2.11	50	7	0
August 7,	1.61	130	9	4	0.41	1.66	117	6	2
1917.									
January 10,	1.13	1,100	86	6	1.10	1.18	54	16	0
January 16,	1.40	1,350	22	3	1.00	1.40	825	20	1
January 29,	1.19	340	15	2	1.04	1.19	25	14	0
March 12,	.83	1,940	40	11	0.39	.78	74	31	1
1918.									
February 15,	.93	7,700	190	55	0.86	.95	620	21	1
February 20,	.80	91,000	220	16	0.74	.80	1,200	150	0
February 28,	.75	12,000	340	1	0.65	.75	550	370	0
March 20,	.78	3,000	65	0	0.53	.79	120	35	0
March 28,	1.06	600	28	0	0.54	1.03	41	18	0
April 3,	1.16	900	70	0	0.57	1.15	78	53	0
April 11,	1.11	150	19	0	0.62	1.06	28	17	0
Average,	1.20	8,600	80	8	0.64	1.20	300	50	0.5

B. coli results are not given in the above table because in all this work the organism was found very infrequently in the untreated river water and seldom when smaller volumes than 10 cubic centimeters were tested. By chlorine treatment about 50 per cent removal was obtained.

Average Bacterial Analyses of Wenham Lake Water.

Date.	Average Number of Samples.	Color.	Bacteria per Cubic Centimeter.			B. Coli in —		
			4 Days, 20° C.	Total.	Red.	0.1 c. c.	1 c. c.	10 c. c.
1916.								
April 6,	1	-	450	11	0	0	0	+
May 23,	1	.32	300	10	0	0	0	0
June 28,	1	-	144	26	12	0	0	+
July 28,	1	-	280	30	6	0	+	+
September 29,	1	-	330	40	10	0	+	+
1917.								
May 24,	1	.64	160	15	2	0	+	+
June 25,	2	.42	165	85	50	0	0	+
July 24,	1	.49	65	4	1	0	0	+
August 21,	1	.37	280	2	0	0	0	0
September 20,	1	.37	110	1	0	0	0	+
November 30,	1	.32	23	1	0	0	0	0
1918.								
May 13,	2	.60	560	8	0	0	0	0
June 6,	1	.38	270	20	0	0	0	0
July 2,	1	.45	40	14	2	0	+	+
September 5,	1	-	80	12	1	0	0	+
Average,	1	.44	220	18	6	0	27+[1]	67+[1]

[1] Per cent.

Lawrence City Filters.

The city of Lawrence takes its supply of water from the Merrimack River, which is badly polluted by the entrance of sewage and mill wastes of cities and towns above Lawrence. Since 1893, a period of twenty-five years, the city has purified this water by sand filtration.

Two filters are used, — one, constructed in 1893, is 2.2 acres in area and divided into three sections by concrete dividing walls, and contains 4 feet in depth of sand of an effective size of approximately 0.25 millimeter; the other, of modern construction, entirely of concrete, covered, etc., was constructed in 1907. This filter has an area of three-quarters of an acre, and contains about 4½ feet in depth of sand of an effective size of 0.25 millimeter.

The effluents from these filters flow into the same pump-well, and

from this they are pumped to a distributing reservoir. During 1917 the easterly section of the old filter was in part reconstructed, a tight concrete bottom and sides being built, and during 1918 this reconstruction was finished, this section being roofed in. The remaining two sections had all their pipe and gravel underdrains renewed and extended during the year. The average volume of water pumped daily from both filters up to September 1, when a portion of the open filter was put out of operation, was about 4,310,000 gallons, and during the year it was necessary to supply the city with a certain volume of water from the Andover and North Andover systems.

The average chemical and bacterial analyses of the effluents from these two filters, and of samples from other points on the Lawrence water supply system, are shown in the following tables: —

Average Chemical Analyses.

Merrimack River. — Intake of the Lawrence City Filters.

[Parts in 100,000.]

Temperature (Degrees F.).	Appearance.		Ammonia.			Chlorine.	Nitrogen as —		Oxygen consumed.	Iron.	Soap Hardness.
	Turbidity.	Color.	Free.	Albuminoid. Total.	Albuminoid. In Solution.		Nitrates.	Nitrites.			
48	0.3	.40	.0213	.0224	.0173	.49	.019	.0009	.57	.0448	1.1
Effluent from Lawrence City Filter (Old Filter).											
51	0.2	.39	.0147	.0117	-	.48	.038	.0009	.42	.0747	1.3
Effluent from Lawrence City Filter (New Filter).											
51	0.0	.29	.0091	.0103	-	.49	.030	.0006	.42	.0343	1.2
Water from the Outlet of the Distributing Reservoir.											
52	0.1	.37	.0089	.0112	-	.51	.035	.0006	.38	.0673	1.2

Average Chemical Analyses — Concluded.

Water from a Tap at Lawrence City Hall.

[Parts in 100,000.]

Temperature (Degrees F.).	Appearance. Turbidity.	Appearance. Color.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Chlorine.	Nitrogen as — Nitrates.	Nitrogen as — Nitrites.	Oxygen consumed.	Iron.	Soap Hardness.
52	0.1	.34	.0076	.0095	-	.51	.035	.0005	.36	.0638	1.3

Water from a Tap at the Lawrence Experiment Station.

54	0.1	.28	.0025	.0123	-	.46	.024	.0002	.29	.0485	1.1

Average Bacterial Analyses.

Merrimack River. — Intake of the Lawrence City Filters.

Bacteria per Cubic Centimeter. 20° C.	Bacteria per Cubic Centimeter. 37° C. Total.	Bacteria per Cubic Centimeter. 37° C. Red.	Per Cent of Bacteria removed. 20° C.	Per Cent of Bacteria removed. 37° C. Total.	Per Cent of Bacteria removed. 37° C. Red.	Per Cent of Samples containing B. Coli. .01 c. c.	Per Cent of Samples containing B. Coli. 0.1 c. c.	Per Cent of Samples containing B. Coli. 1 c. c.	Per Cent of Samples containing B. Coli. 10 c. c.
18,000	1,400	400	-	-	-	70	98	100	-

Effluent from the Lawrence City Filter (Old Filter).

180	13	2	99.0	99.5	99.5	-	12	22	73

Effluent from the Lawrence City Filter (New Filter).

80	8	2	99.5	99.4	99.5	-	0	24	75

Mixed Effluents as pumped to Distributing Reservoir.

190	12	2	-	-	-	-	19	30	82

Water from the Outlet of the Distributing Reservoir.

200	14	1	-	-	-	-	6	23	68

Average Bacterial Analyses — Concluded.

Water from a Tap at Lawrence City Hall.

Bacteria per Cubic Centimeter.			Per Cent of Bacteria removed.			Per Cent of Samples containing B. Coli.			
20° C.	37° C.		20° C.	37° C.		.01 c. c.	0.1 c. c.	1 c. c.	10 c. c.
	Total.	Red.		Total.	Red.				
100	10	1	-	-	-	-	0	11	35

Water from a Tap at the Lawrence Experiment Station.

150	10	1	-	-	-	-	6	10	49

Refiltration of Lawrence City Water.

Filter No. 343A, $\frac{1}{20000}$ of an acre in area, started in 1908, was continued in operation during 1918, and at the end of the year contained 28 inches in depth of sand of an effective size of 0.35 millimeter. Since July, 1913, water from the city mains has been applied at a theoretical rate of 5,000,000 gallons per acre daily. The average color removal by this filter was 33 per cent; 61 per cent of the iron in the applied city water was removed, and 80 per cent of the bacteria.

Average Chemical Analyses.

City Water applied to Filter No. 343A.

[Parts in 100,000.]

Quantity applied. — Gallons per Acre.	Appearance.		Ammonia.		Chlorine.	Nitrogen as —		Oxygen consumed.	Iron.	Alkalinity.	Soap Hardness.
	Turbidity.	Color.	Free.	Total Albuminoid.		Nitrates.	Nitrites.				
-	0.1	.30	.0052	.0135	.53	.031	.0003	.32	.0545	1.0	1.2

Effluent from Filter No. 343A.

4,785,000	0.0	.20	.0047	.0089	.52	.033	.0002	.26	.0214	1.1	1.2

Average Bacterial Analyses.

Bacteria per Cubic Centimeter.			Per Cent of Bacteria removed.			Per Cent of Samples containing B. Coli.		
20° C.	37° C.		20° C.	37° C.		0.1 c. c.	1 c. c.	10 c. c.
	Total.	Red.		Total.	Red.			
150	10	1	-	-	-	-	10	49
Effluent from Filter No. 343A.								
30	3	0	80	70	100	-	7	12

DIVISION OF FOOD AND DRUGS.

HERMANN C. LYTHGOE, *Director*.

Report of Division of Food and Drugs.

During the year 1918 the Food and Drug Division of the Massachusetts State Department of Health has been engaged in the usual routine work relative to the enforcement of the milk, food, drugs, cold storage and slaughtering laws, and in the examination of samples submitted by the police authorities, as well as in the manufacture of arsphenamine.

The new laboratory facilities have been completed after many delays. These delays seriously curtailed all food and drug research work, and also curtailed the manufacture of arsphenamine to a considerable extent.

There have been quite a few changes in the personnel of the Division during the past year. Mr. Charles H. Hickey, assistant analyst, resigned to accept an industrial position, and his place was filled by the permanent appointment of Mr. Howard D. Williams who was temporarily employed. Shortly after this Mr. Williams was inducted into the United States service, and his place was filled by the appointment of Miss Bernice H. Alderman. Mr. M. P. Crowe resigned his position as inspector, and his place was filled by the appointment of Mr. Arnold C. Perham. Dr. George L. Drury, during the latter part of the year, enlisted in the United States service as second lieutenant, Veterinary Corps. His place has not been filled, as undoubtedly he will be discharged from the United States service early during the coming year. Miss Celeste E. Macaulay, the chief stenographer, died during the influenza epidemic, and her place was filled by the promotion of Miss Eleanor J. Brogan. A new stenographer, Miss Anna E. Daley, is to be employed Dec. 1, 1918. In the manufacture of arsphenamine four male and three female laboratory assistants are now employed.

The Division has been very much handicapped by the distribution of funds in the last budget. More money than was necessary was appropriated for salaries, and the appropriation for expenses was insufficient. This means that the Division must return an unexpended balance at the close of the fiscal year. At the same time, we were obliged to curtail field work during the month of August and to practically cease this work on the 1st of September. Were it not for the fact that fifteen mileage books were on hand at the beginning of the fiscal year, the field work would have been discontinued much earlier.

It will be necessary to have considerably more money for the coming year, due first, to the increase in railroad rates; second, to increase in hotel rates; third, to increase in chemical and laboratory supplies; and fourth, to increase in the price of samples purchased by the inspectors.

Notwithstanding this deficiency in money, the Division materially increased its work over that during the previous year. A comparison of the work of the two years is given in the following table: —

	1918.	1917.
Milk samples,	7,738	7,060
Food samples,	2,142	1,704
Drug samples,	396	794
Samples submitted by police,	210	360
Total samples,	10,486	9,718
Prosecutions,	337	307
Fines imposed,	$8,143.10	$5,560.60
Confiscations,	87	124
Weight of confiscated articles (pounds),	157,557	305,000

The number of court cases, and particularly the fines, are much heavier. This is due, primarily, to the increased number of samples collected, but the heavy amount of fines is due to the exceptionally large fines imposed in a number of cases. The milk cases were naturally the most numerous, and, as usual, the increase in the price of milk seems to result in an increase in adulteration of milk.

There were prosecuted and convicted 14 cases for the sale of low standard milk; 13 cases for the sale of skimmed milk, 4 of which were dismissed for want of prosecution, and 9 of which were convicted; and there were 80 cases prosecuted for the sale of watered milk, of which 6 were discharged, 1 was dismissed for want of prosecution, and 1 on which sentence was suspended; the balance were convicted. There was 1 conviction for the sale of dirty milk, 2 convictions for misuse of milk bottles, 3 convictions for the sale of adulterated cream, and 2 convictions for the sale of low standard cream.

There were 54 cases for the sale of adulterated foods; 3 cases for the sale of adulterated honey; 4 cases for the sale of adulterated lard; 1 case for the sale of adulterated mince meat; 36 cases for the sale of adulterated olive oil; and 8 cases for the sale of adulterated sausages, resulting in conviction. One case involving salt cod fish was discharged. One case for the sale of watered scallops was discharged.

There were 20 cases for the sale of decomposed foods, of which 14 related to eggs; 2 to meat; and 2 to nuts, resulting in conviction. Two cases relating to meat were discharged.

For the sale of stale eggs as fresh eggs there were 7 convictions; 6 cases dismissed without finding, on payment of costs; and 1 case nol-prossed.

For violation of the cold-storage laws there were 101 cases, of which 96 were convicted and 5 discharged.

For violation of the slaughtering laws there were 13 cases, of which 10 were convicted and 3 discharged.

For the sale of adulterated drugs there were 19 cases, of which 18 were convicted and 1 nol-prossed.

Some of the court cases deserve special comment.

There were two cases tried in Adams, one for the stamping of a carcass which the inspector had not seen slaughtered, the other for the slaughtering of an animal in the absence of an inspector. The evidence involving both cases was identical. The court convicted one man and acquitted the other.

One case was tried for the sale of fish containing added fish bones. The United States Department of Agriculture furnished information in this case that the corporation in question was making salt fish to which about 30 per cent of fish bones were added. The analysis of the sample indicated that this evidence was correct. The court, however, declined to convict. This salt fish was finely ground up, and the bones could not be removed by the person who was preparing food from the article in question.

A case against the Armour Company was dismissed in the lower court on the ground that the Federal Food Administration had set aside the Massachusetts cold-storage law. One of the inspectors of this Department then obtained evidence of a number of technical violations on the part of Armour & Co., and the case was referred to the district attorney, who obtained an indictment. In these cases Armour had permission from the United States Food Administration to hold certain poultry in storage beyond the twelve months allowed by the Massachusetts law. The poultry was removed in from two to six weeks after the year had expired. A conviction was secured in this case in the Superior Court, and the Armour Company did not desire to carry the case to the Supreme Court. Under ordinary conditions this case would never have been put into court, but at that time it was essential to establish the standing of our cold-storage law with respect to the United States law.

Two cases of note were tried during the year, pertaining to violations of the slaughtering laws. The town of Rockland declined to appoint a slaughtering inspector. A man in that town killed two hogs

and then requested the former inspector to apply the official stamp. He was referred to the local board of health. The secretary of the board of health then gave the stamp to a man and told him to go to the market where these dressed hogs were and apply the stamp. A request was made to this Department to investigate the circumstances. One of the inspectors visited Rockland, found the hogs, found that they were not fit for food and confiscated them. The man who caused the hogs to be butchered and the man who did the stamping were summoned into court, pleaded guilty, and paid their fines.

A slaughtering case involving diseased meat was secured in Lowell. One of the inspectors found the hind quarter of a beef animal in a sausage factory. He did not like the appearance of the meat, and upon sticking a knife into it found that it was completely infiltrated with pus. The carcass bore the stamp of the town of Reading. Further investigation was made in Reading, and it appeared that the carcass came from a bull which had been lame for some time. The farmer who owned the bull sold him to the butcher who killed the animal on the farm and carried the carcass to the slaughterhouse. Subsequently, the inspector stamped the carcass. The inspector acknowledged stamping the carcass he had not seen killed. Inasmuch as this case covered the jurisdiction of two courts, an attempt was made to have the district attorney handle the matter before the grand jury, but he declined. We therefore took the sausage maker into court in Lowell for using diseased meat in the manufacture of food. He was convicted and fined. The other cases were taken into court in Woburn, and the butcher and inspector were both found not guilty. The court refused to allow the admission of a statement of conversation between the inspector and the butcher relative to the sale. Without this evidence it was impossible to convict. Relative to the inspector, the court held that the term "time of slaughter" meant any time from the actual killing of the animal to the application of the official stamp. This inspector has been convicted twice for violation of the slaughtering laws. He was disapproved by this Department because of these convictions, but upon receipt of a letter from the board of health that they guaranteed to remove him if any further irregularities were discovered, his disapproval was reconsidered and he was approved. After these cases were over the board of health was asked to live up to its agreement, which it declined to do.

A number of cases had been referred to the United States Department of Agriculture for violation of the food and drug law by shipping adulterated milk into Massachusetts. This procedure has been unsatisfactory, first, owing to the refusal of the Department to prosecute

certain cases, — specifically cases where the Massachusetts dealer went into the other State and acted as his own carrier; and second, because of twelve months' delay in their arriving at a decision relative to the advisability of prosecution. Four cases of this nature were obtained in the fall of 1917 and were referred directly to the United States attorney as per the United States foods and drugs act. The United States attorney for Vermont referred these cases to the United States Attorney-General, and subsequently informed the Department that the United States Attorney-General's office stated that there was no violation of the law. A few weeks ago, after this information was received, the matter was referred to the Attorney-General of this Commonwealth, who took the matter up with the office of the United States Attorney-General and secured a reversal of their decision. We were then summoned to appear before the Vermont grand jury. The cases were put on by the United States attorney and indictments secured in all instances. In all four cases the defendants pleaded guilty and paid fines of $50 each. The United States attorney stated that he sent the information to Washington merely for a ruling on the collection of evidence by State officers who were not United States officers, and he was rather surprised at the reply he received which was to the effect that no interstate shipment of milk had been made on the part of the defendants. He was thoroughly satisfied, however, that with the possible exception of authority to take samples, we had made out a perfect case. He was informed that in this instance we did not take the samples until they were ready for delivery to the Massachusetts milk dealer, and they were taken then with the consent of the Massachusetts dealer. The United States attorney was further informed that we realized that we had absolutely no right to go into New Hampshire and seize samples of foods intended for interstate shipment.

A number of other cases had been referred to the United States attorneys in Rhode Island and New York for violation of the milk law and for the shipment of adulterated maple sugar and of adulterated olive oil. The attorney for New York has referred all these cases to the United States Department of Agriculture, although the law says he shall act upon advice received from State Health Officers.

In one of these cases the United States attorney and the United States Department of Agriculture admit that we have made out a perfect case. Nevertheless, the United States attorney declines to prosecute because the New York dealer shipping the maple sugar into Massachusetts claims he did not know the sugar was adulterated, although he bought his sugar without a guarantee and bought it at a price lower than the market price for maple sugar.

The cases involving the interstate shipment of olive oil have not been reported on yet by the United States attorney. The United States attorney for Rhode Island has asked for affidavits on the cases submitted to him. These have been furnished, and the material will be used in preparing information for submission to the United States court in Rhode Island during the coming year.

Special investigations were made upon the sale of eggs. It was found that, in general, retail dealers were selling eggs of all descriptions as fresh eggs. The false advertising law was used successfully in curbing violations of this character. In one instance a store keeper was found to be buying but one grade of cold-storage eggs, and was putting these eggs out at various prices because some of his customers did not care to buy cheap eggs but desired high-priced eggs. In two instances of this character the dealers were fined $200, primarily because they were aliens of draft age, one of whom was an alien enemy. These cases were appealed, and the district attorney supported the justice of the lower court in his contention that the fines in these instances should be excessive.

The confiscations were much less than those reported last year. This was in some measure due to the increased cost in foodstuffs, and possibly due to the fear, on the part of dealers, of the regulations of the Food Administration, which imposed severe penalties upon anybody who wasted food. The railroads were the greatest offenders in this respect. In one instance an inspector of this Department was called upon to confiscate a carload of smelts which was one month in shipment from the Pacific coast. This represented 25,000 pounds of good food which never should have been wasted.

The following is a summary of the confiscated articles: —

Articles in Cold Storage condemned upon Physical and Chemical Examinations as Unfit for Food.

Articles.	Number of Confiscations.	Weight (Pounds).
Eggs, case,	1	4[1]
Eggs, frozen,	3	3,610
Butter,	1	620
Poultry,	11	1,440
Game,	1	10
Meat, fresh, and meat products, fresh,	17	62,475
Fish, fresh food,	3	25,277
Totals,	37	93,432[2]

[1] Cases. [2] Also 4 cases.

Articles in Stores, Markets and Sausage Factories condemned upon Physical and Chemical Examinations as Unfit for Food.

Articles.	Number of Confiscations.	Weight (Pounds).
Eggs,	1	315
Poultry,	3	45½
Venison,	1	75
Meat, fresh, and meat products, fresh,	39	6,222½
Fish,	4	55,387
Grapes,	1	2,128[1]
Totals,	49	62,045[2]

Articles in Slaughterhouses condemned upon Physical and Chemical Examinations as Unfit for Food.

Meat,	11	1,960

[1] Packages. [2] Also 2,128 packages.

The new food and drug law of 1917, which superseded our former food and drug law, and which was passed largely through the instrumentality of the Boston Chamber of Commerce, went into effect upon May 1 of the present year. This law was somewhat criticised in the report of last year, but it has not yet been in operation for a sufficient length of time to ascertain its defects, as there have been but very few contests over the cases which have been tried. One contested case recently tried was lost notwithstanding the fact that the Department had complied as closely as possible with all the technical details which the law contains for the protection of the dealers. The lawyer who defended the case told the assistant analyst that in his opinion the law was inoperative if properly defended, and advised against its use by the Department. The judge who heard the case said that the law was not intended for the protection of the public from the sale of adulterated foods, but that it certainly gave the dealer all the opportunity to escape from its penalties by reason of the technical objections placed in the opposition of the prosecution.

It is inadvisable to try to correct this law at the coming legislative session, as there are undoubtedly many so-called jokers existing therein which will be discovered from time to time.

This law provides for the adoption of regulations by this Department. It has been impossible to do this, owing to the absence of

sufficient funds to print and distribute any regulations which may be adopted. This, however, must be done shortly after the opening of the next fiscal year, attempting wherever possible in these regulations to correct some of the technical defects which have become apparent.

There have been collected and examined 7,738 samples of milk, of which 7,617 were collected by the inspectors. Of these samples, 2,249 contained less than the 12 per cent of solids required by law, and included 24 samples of skimmed milk sold as such, 172 samples of skimmed milk sold as pure milk, and 424 samples containing added water. There were 3 samples of milk containing sufficient dirt to be considered adulterated. Of the 6,539 samples obtained from milk dealers, 212 were watered and 164 were skimmed, and not so labeled. Wherever possible each instance of adulteration was thoroughly investigated, which resulted in the collection of 1,043 samples of milk from suspected producers, of which 198 samples were watered and 3 were skimmed. Of the samples collected from suspected producers, 63 were obtained outside of the State.

A campaign was waged against restaurants, owing to the practice of serving skimmed milk to their customers. A letter was sent to local milk inspectors, informing them that it was the intention of the Division to prosecute restaurant keepers wherever skimmed milk was served, without first giving a warning as had been the previous custom. Some local inspectors notified the restaurants under their jurisdiction of this proposed action, and in some instances copies of the letter were published in local newspapers. This action resulted in some improvement in the restaurant situation. There is still room, however, for more improvement in this line.

Notwithstanding the increase in the cost of milk, and the fact that the price to the farmer is based upon the fat content, there has been a reduction in the average quality of milk sold throughout the State. For the past ten years the Division has computed the composition of the average milk samples collected, exclusive of those which could be declared skimmed or watered. By this means we can arrive at an approximation of the quality of milk sold throughout the State. The composition of the average milk, exclusive of adulterated milk sold in the State during the past ten years, is shown in the following table: —

YEAR.	Number of Samples.	Solids (Per Cent).	Fat (Per Cent).	Solids not Fat (Per Cent).
1909, ...	4,242	12.78	4.10	8.68
1910, ...	5,082	12.85	4.02	8.83
1911, ...	4,341	12.83	4.00	8.83
1912, ...	4,516	12.66	3.89	8.77
1913, ...	6,154	12.69	3.84	8.85
1914, ...	5,502	12.70	3.82	9.88
1915, ...	6,765	12.68	3.82	8.86
1916, ...	7,458	12.66	3.72	8.94
1917, ...	6,317	12.53	3.73	8.80
1918, ...	6,995	12.47	3.76	8.71

Investigations of the character of ice cream sold indicated that while the percentage of fat corresponded in general to the requirements of the law, the samples brought in by the inspectors were much smaller in quantity than during the previous years. Further investigation revealed that this was due to the introduction of large amounts of air during the process of manufacture. This introduction of air is highly profitable, since ice cream is sold by volume and not by weight, and air is naturally much cheaper than the other ingredients of ice cream. Several one-half pint samples were obtained and these were weighed; 5 samples varied in weight from 105 to 165 grams; 5 samples varied from 175 to 215 grams; and 2 samples weighed 250 and 265 grams, respectively. There were very few samples below the standard. Only 4 of the 269 collected contained less than 7 per cent of fat. All these samples were made by persons operating small stores. These people were unfamiliar with the law and had made their ice cream from milk. Warnings were given in all instances of this nature.

The district attorney of Middlesex County asked for information relative to the character of the water used in ice-cream parlors and at soda fountains, in which the scoops were allowed to stand when not in use. Since the Department did not possess any information upon this subject, an investigation was made during September, and it was found that the water was unusually clean bacteriologically, and was by no means as bad as its physical appearance would lead one to believe. It was found that in many cases the water was changed several times per day. The samples were all taken during warm weather, when the conditions would naturally be as bad as possible. A summary of the results obtained is as follows: —

Five samples contained from 0 to 1,000 bacteria per cubic centimeter, with an average bacteria content of 71 per cubic centimeter.

Ten samples contained between 1,000 and 10,000 bacteria per cubic centimeter, with an average bacteria content of 4,645 per cubic centimeter.

Nine samples contained from 10,000 to 56,700 bacteria per cubic centimeter, with an average bacteria content of 21,139 per cubic centimeter.

The average of all the samples was 11,737 bacteria per cubic centimeter.

In those cities and towns where regulations relative to the bacteria content of ice cream have been made, a maximum limit of 500,000 bacteria per cubic centimeter has been set. None of these samples of wash water approached that limit, and the average was considerably below.

There were collected and examined 2,143 samples of foods, of which 588 were adulterated. Many of these samples reported adulterated, such as fish, meat and condensed milk, were not purchased on the market, but were taken for analysis as a preliminary to confiscations.

The Food Administration submitted a number of samples of butter, canned goods, cereals, cocoa, crackers, confectionery, fish, gum, jellies and peanut butter to be examined for the presence of poisons. All of these samples were submitted to the Food Administration by the general public, and, needless to state, nothing deleterious was found.

The United States Army submitted samples of soft drinks, cattle feed and other samples, including one of intestinal fluid obtained during an autopsy. We declined to examine the latter specimen, but all the others were examined and reports were sent to the army.

The Adjutant-General's office submitted a number of specimens, the analyses of which were of alleged military value. Nothing unusual, however, was found in any of these specimens.

The public submitted a number of samples said to be poisonous, or to have caused sickness, or to have contained ground glass. Nothing unusual was found in any of these samples.

Local inspectors submitted six specimens for pathological examination, only one of which was such that the carcass in question could be passed for food purposes.

The Food Administration, desiring to enforce the regulations as to the use of substitute flours in bakehouses, conferred with the Division relative to making examinations of bread samples. It was assumed that a number of samples would be submitted, but no requests for examination were received and no samples were submitted. In anticipation of this possible request, considerable research work was carried on to ascertain whether or not the percentage of substitutes in the

bread could be detected after baking. We were unable to obtain any satisfactory methods other than the usual method of making microscopic examinations of the dough before baking.

Of the adulterated samples not discussed elsewhere, one was a sample of oleomargarine submitted by a local milk inspector; one was a sample of renovated butter; 1 was a sample of butter high in water; and 3 were samples of rancid butter. The adulterated samples of clams, oysters and scallops were watered. The adulterated samples of cider, mince meat, soft drinks and hamburg steak contained preservatives. The adulterated samples of canned goods, condensed milk, candy, fish, beef, veal, pork, some of the sausages, nuts and shrimp were decomposed. The balance of the sausages contained starch or vegetable material in excess of 2 per cent. The single adulterated sample of peanut butter contained about 1 per cent of grit. An inspection of the factory, however, indicated that all necessary precautions were taken to insure a clean product. It occasionally happened that a small stone about the size of a peanut managed to get through the various cleaning processes, and naturally was ground up with the peanuts. The vinegar samples reported adulterated were somewhat low in acetic acid.

One of the inspectors, carrying out some work for another Division, found a large amount of sugar stored away in a barroom. The proprietor said he did not know the nature of the material or who owned it. The inspector took samples, the samples were examined, and the information turned over to the Food Administration. The Food Administration seized the sugar. When this information was published in the papers by the Food Administration, the report stated that the information was received from the County Food Administrator.

The drug samples examined were much less than those of previous years, due entirely to the smallness of our appropriation. It was deemed inexpedient to spend more money than was absolutely necessary upon the purchase of these samples. In all, 396 samples were examined, of which 126 were adulterated. No unusual adulterants were detected.

A number of attempts were made to utilize the misbranding provisions of the new food and drug law in cases pertaining to the sale of patent medicines. These medicines, however, are so cleverly labeled that it is practically impossible to maintain a case of any sort against any person selling them. One remedy, however, the B. & M. Remedy for Tuberculosis, apparently was a violation of this law. This remedy pretends to absolutely cure tuberculosis and various other diseases, and its analysis showed it to consist of an emulsion of turpentine, ammonia,

water and egg white. A small amount of carbolic acid was found in one of these samples. The proprietor of this remedy, however, is without any doubt absolutely honest in his belief that the remedy can effect the cure which he claims, and under no circumstances could he be convicted of fraud in connection with the sale of this remedy. Therefore no prosecution could be undertaken.

The cold-storage warehouses have been inspected as usual, and the conditions, in general, have been found to be satisfactory. As would naturally be expected, there has been a considerable increase in the storage of goods in this State. This is largely due to war conditions, as we are shipping food to Europe not only for the civilian population, but also for the 2,000,000 soldiers which we have "over there." The food intended for export shipment is sent from Chicago to Albany, and is there held until it is known from where it will be shipped. Then it is sent to either Boston or New York, as the case may be, and held until placed on board the vessel for shipment. The result of this condition represents tremendous amounts placed in storage, but the holdings of butter and eggs reported do not indicate any unusual amount of goods on hand.

Table 1 gives a summary of the monthly reports of the cold-storage warehouses, showing articles placed in storage, and eggs and butter on hand.

The following table, compiled from the reports submitted since the storage law went into effect in this State, gives an idea of the increase in storage in this State. The great increase has been in meat and fish, both of which are no doubt due to the export of these articles. The storage of butter, poultry and eggs has been fairly uniform throughout all these years.

Articles in Cold Storage.

	1913.	1914.	1915.	1916.	1917.	1918.
Eggs, case (million dozens), . .	23.9	21.6	26.0	20.9	22.9	25.0
Butter (million pounds), . .	28.3	32.1	38.5	35.8	36.7	37.9
Poultry (million pounds), . .	9.8	14.6	16.8	15.5	9.8	16.3
Meat (million pounds), . .	14.2	26.1	47.2	51.8	63.2	115.4
Fish (million pounds), . . .	17.8	22.4	27.0	31.8	45.9	51.9

The number of extensions granted on goods in cold storage is less than last year. Only 162 extensions were granted. The total weight of the goods covered by these extensions is 570,640 pounds, which

represents 0.23 per cent of the total goods placed in storage. By far the most of this was beef purchased under contract by the allied governments and held for shipment. In 132 instances goods were ordered out of storage at the close of the twelve months permitted by law. In 1917 but 40 lots were ordered out at the close of a year's storage. In 32 instances extensions were refused. Forty requests for permission to remove articles which had been in storage for longer than twelve months were granted.

Tables 2, 3, 4 and 5 give the details of the cold-storage extensions.

In acting upon these extensions the Division was to a considerable extent influenced by the attitude of the Food Administration. Extensions on poultry and frozen eggs were given in accordance with written communications from the Food Administration. These represented the largest excessive storage of articles intended for domestic consumption.

The extensions on poultry were made in accordance with a request received prior to the beginning of the fiscal year. Owing to the sugar shortage, it was evident that egg whites in storage could not be used for food purposes, as they are used almost exclusively by bakers in making frostings. The Food Administration was therefore requested by this Division to give an opinion relative to the extensions which should be allowed on frozen egg whites. We were verbally informed to grant these extensions until the 1st of August, and the extensions were therefore granted in accordance with this suggestion. The holders of the eggs protested, and were advised to carry their protests to the Food Administration because our action was based upon advice received from that source. As the result of this protest we were requested in writing to grant these extensions until the 1st of November, to which request we rigidly adhered. Later we were requested in writing to increase these extensions until the first day of January. This was done. It should be understood in this respect that all these extensions are illegal at present. The United States Food Administration law prohibits the hoarding of food, and the regulations of the Food Administration define hoarding as "the holding of food longer than over the period of scant or no production." It is evident, therefore, that the holding of food in storage for more than twelve months is a direct violation of the Food Administration law. The granting of additional time on extensions is not permitted by our State law. Under these circumstances, this Department was obliged to violate both of these laws and permit this food to remain in storage, which could not be used at that time, and if removed from storage would have deteriorated and would have been destroyed.

The conditions under which slaughtering is carried on, while far

from being satisfactory, are much better than those of former years. The change in the laws, enacted two years ago, which permits a person not engaged in the slaughtering business to slaughter his own animals for his own use without inspection, has caused more or less trouble, and this law should be amended to require all slaughtered animals to be inspected.

Some persons, on ascertaining that the carcass was to be confiscated, have informed the inspector that they would take the carcass home and eat it themselves, and one or two reports were made of threats to local inspectors if they confiscated the carcasses. In one instance a man broke into the slaughterhouse and carried off the carcass before a representative from the rendering company had arrived. Reports have been received that persons have slaughtered hogs without inspection, as they had a right, but that they had salted the pork and subsequently sold the pork to stores. This is a difficult matter to control under present conditions.

A summary of the inspectors' reports of the number of carcasses inspected and confiscated during the year shows a great decrease when compared with the 1917 figures. Somewhat over 30,000 less carcasses were inspected this year, or about 1,000 cattle, 12,000 calves and 16,000 hogs. It does not appear that there could be such a decrease in slaughtering, and probably the killing without inspection, as provided for in the statutes, accounts, to a considerable degree, for the apparent diminution in slaughtering. The confiscated carcasses bear about the usual relation to the total number of carcasses inspected, and the diseases for which the carcasses were confiscated are at present in about the same proportion as in former years, tuberculosis in cattle and hogs, immaturity in calves, and hog cholera in hogs being responsible for 83 per cent of the total confiscations.

In the manufacture of arsphenamine it was found necessary to change the process, and by this change we have been able to increase the yield of finished product at less labor and to produce a product of less toxicity. In the process described last year each of the intermediate products was repurified. In the process used at present only one of the products needs to be repurified.

The United States Public Health Service has increased the requirements, but our product has been able to keep step with all these increases. It appears that this requirement will be again increased when it will be necessary to repurify one of the intermediate products, which will result in a slight delay in time and possibly in a small loss of substance. A large glass-lined tank with stirring and heating apparatus has been installed for the manufacture of arsanilic acid. A dis-

tilling apparatus has been designed and installed for the recovery of aniline and of alcohol. There was an enormous delay in the installation of this material, which led to practically three months of inactivity in this work. At present, apparently there will be no delay in the manufacture of this drug during the coming year.

During the past year 2,936 doses of arsphenamine have been made and distributed. Of this number, 994 were made during November. The rate of production during the coming year will probably be in the neighborhood of 2,500 doses during December, and 4,000 doses during January.

The Division is working under very adverse conditions in making arsphenamine, principally because of insufficiency of space and because of the unavailability of the space at our disposal. For carrying out this work in very large quantities, such as the commercial houses undertake, where several shifts of men are employed, we should have special laboratories devoted to this work alone. There should be one room devoted to the manufacture of arsanilic acid; another room devoted to the manufacture of other intermediates; a third room for the manufacture of the final product; and a fourth room for bottling. At present all the manufacturing is done in one room. The bottling is done in the office, and a portion of the manufacturing work, namely, the preparation of absolute alcohol and absolute ether, is done in a portion of the office of the Director of the Division.

One interesting feature of this work is the reduction in price offered by the commercial houses who desire to sell this article to us for the use of our clinics. The prices have been slowly coming down. No doubt, if the Department were to cease manufacturing the prices would promptly increase.

Because of the termination of hostilities, the patent question is now becoming serious. In all probability a suit will be brought against the Federal Trade Commission for the royalties which would have accrued under the patent, provided the Germans had been able to get the article upon the United States market. If it is impossible to break the patent, these royalties must undoubtedly be paid. We have not undertaken to secure a license from the Federal Trade Commission, principally because of the expense in securing such license, which is $100 for each patent. There are, in all, five patents to be covered. It may, however, be advisable to secure such a license during the coming year.

COLD STORAGE STATISTICS.

TABLE 1. — *Articles placed in Cold Storage from Dec. 1, 1917, to Dec. 1, 1918.*

ARTICLES PLACED IN COLD STORAGE.	December, 1917.	January, 1918.	February, 1918.	March, 1918.	April, 1918.	May, 1918.	June, 1918.	July, 1918.	August, 1918.	September, 1918.	October, 1918.	November, 1918.	Totals.
Eggs, case (dozens),	120,063	33,960	127,770	398,586	8,049,683	8,408,073	3,488,920½	1,313,608	940,718	782,211	959,590	406,050	25,029,232½
Eggs, broken out (pounds).	187,164	192,100	136,519	163,241	115,971	273,556	263,958	278,972	242,800	128,852	214,011	180,439	2,377,583
Butter (pounds),	538,108	280,245	662,321	1,796,715	915,049½	766,814½	8,011,148	10,314,014	5,505,407	2,547,106	3,294,634	3,236,785	37,868,347
Poultry (pounds),	1,543,737	3,343,352	1,967,102	999,950	255,498	779,025½	854,840	922,207	799,038	705,118	1,119,135	2,965,025	16,254,027½
Game (pounds),	7,586	1,060	1,550	4,812	612	242	115	662	746	1,422	7,782	13,415	40,004
Meat, fresh, and meat products, fresh (pounds).	8,421,135	6,542,943	5,329,232	10,327,867	14,464,592	19,158,740	7,410,552	8,051,962	9,713,360	6,296,167	9,866,661	9,780,602	115,363,813
Fish, fresh food (pounds),	1,716,365	2,171,379	2,106,043	4,071,101	5,184,534	7,159,940	8,415,207	7,127,278	4,733,032	2,343,028	3,905,524	2,973,887	51,907,318
Totals,	12,534,158	12,565,039	10,330,537	17,762,272	28,985,939½	36,546,391	28,444,740½	28,008,703	21,935,101	12,803,904	19,367,337	19,556,203	248,840,325

Butter and Eggs held in Cold Storage from Jan. 1, 1918, through Dec. 1, 1918.

ARTICLES HELD IN COLD STORAGE.	Jan. 1, 1918.	Feb. 1, 1918.	Mar. 1, 1918.	Apr. 1, 1918.	May 1, 1918.	June 1, 1918.	July 1, 1918.	Aug. 1, 1918.	Sept. 1, 1918.	Oct. 1, 1918.	Nov. 1, 1918.	Dec. 1, 1918.
Eggs, case (dozens),	5,212,755	1,218,757	40,950	192,420	8,021,064	16,047,336	18,883,611	18,692,031	17,763,681	16,369,697	13,047,600	9,003,143
Eggs, broken out (pounds),	554,689	402,032	442,446	426,896	410,576	432,609	535,767	642,372	569,701	499,232	418,312	327,007
Butter (pounds),	11,428,644	6,600,650	3,752,997	2,966,526	1,828,981½	798,242	8,063,252	16,114,385	18,876,072	17,508,065½	16,375,372	14,248,021
Totals,	17,196,088	8,221,439	4,236,393	3,585,842	10,260,621½	17,278,187	27,482,630	35,448,788	37,209,454	34,376,994½	29,841,284	23,578,171

TABLE 2. — *Summary.*

Requests for extension of time granted,		162
Eggs,	32	
Butter,	12	
Poultry,	93	
Game,	2	
Meat,	13	
Fish,	10	
Requests for extension of time not granted,		32
Eggs,	1	
Butter,	6	
Poultry,	15	
Meat,	8	
Fish,	2	
Requests for permission to remove granted,		40
Eggs,	3	
Butter,	7	
Poultry,	19	
Game,	3	
Fish,	8	
Articles ordered removed from storage (no request made),		129
Eggs,	2	
Butter,	10	
Poultry,	39	
Game,	4	
Meat,	54	
Fish,	20	

TABLE 3. — *Requests for Extension of Time granted from Dec. 1, 1917, to Dec. 1, 1918, on Goods in Cold Storage.*

[Reason for such extension being that goods were in proper condition for further storage.]

ARTICLE.	Weight (Pounds).	Placed in Storage.	Extension granted to —	Name.
Eggs, canned,	5,940	July 14, 1917	Aug. 1, 1918[1]	Poole, J. R., Company.
Eggs, canned,	4,020	July 14, 1917	Nov. 1, 1918[1]	Poole, J. R., Company.
Eggs, canned,	2,040	Aug. 4, 1917	Nov. 1, 1918[1]	Poole, J. R., Company.
Eggs, frozen,	330	May 4, 1917	June 20, 1918	Green & Co.
Eggs, frozen,	600	May 5, 1917	June 20, 1918	Green & Co.
Eggs, frozen,	675	May 7, 1917	June 20, 1918	Green & Co.
Egg whites, frozen,	990	May 3, 1917	Jan. 1, 1919[1]	Goldsmith-Wall-Stockwell Company.
Egg whites, frozen,	1,680	May 10, 1917	Jan. 1, 1919[1]	Goldsmith-Wall-Stockwell Company.
Egg whites, frozen,	660	May 12, 1917	Jan. 1, 1919[1]	Goldsmith-Wall-Stockwell Company.
Egg whites, frozen,	540	May 14, 1917	Jan. 1, 1919[1]	Goldsmith-Wall-Stockwell Company.
Egg whites, frozen,	930	May 15, 1917	Jan. 1, 1919[1]	Goldsmith-Wall-Stockwell Company.
Egg whites, frozen,	990	May 16, 1917	Jan. 1, 1919[1]	Goldsmith-Wall-Stockwell Company.

[1] Extension granted to this date in accordance with request from the Food Administration.

TABLE 3. — *Requests for Extension of Time granted from Dec. 1, 1917, to Dec. 1, 1918, on Goods in Cold Storage* — Continued.

ARTICLE.	Weight (Pounds).	Placed in Storage.	Extension granted to —	Name.
Egg whites, frozen, .	330	May 17, 1917	Jan. 1, 1919	Goldsmith-Wall-Stockwell Company.
Egg whites, frozen, .	1,290	May 18, 1917	Jan. 1, 1919[1]	Goldsmith-Wall-Stockwell Company.
Egg whites, frozen, .	1,080	May 21, 1917	Jan. 1, 1919[1]	Goldsmith-Wall-Stockwell Company.
Egg whites, frozen, .	1,050	May 22, 1917	Jan. 1, 1919[1]	Goldsmith-Wall-Stockwell Company.
Egg whites, frozen, .	330	May 23, 1917	Jan. 1, 1919	Goldsmith-Wall-Stockwell Company.
Egg whites, frozen, .	960	May 24, 1917	Jan. 1, 1919[1]	Goldsmith-Wall-Stockwell Company.
Egg whites, frozen, .	780	May 28, 1917	Jan. 1, 1919[1]	Goldsmith-Wall-Stockwell Company.
Egg whites, frozen, .	840	June 7, 1917	Jan. 1, 1919[1]	Goldsmith-Wall-Stockwell Company.
Egg whites, frozen, .	960	June 8, 1917	Jan. 1, 1919[1]	Goldsmith-Wall-Stockwell Company.
Egg whites, frozen, .	840	June 11, 1917	Jan. 1, 1919[1]	Goldsmith-Wall-Stockwell Company.
Egg whites, frozen, .	900	June 13, 1917	Jan. 1, 1919[1]	Goldsmith-Wall-Stockwell Company.
Egg whites, frozen, .	870	June 14, 1917	Jan. 1, 1919[1]	Goldsmith-Wall-Stockwell Company.
Egg whites, frozen, .	585	June 15, 1917	Jan. 1, 1919[1]	Goldsmith-Wall-Stockwell Company.
Egg whites, frozen, .	870	June 19, 1917	Jan. 1, 1919[1]	Goldsmith-Wall-Stockwell Company.
Egg whites, frozen, .	1,290	June 20, 1917	Jan. 1, 1919[1]	Goldsmith-Wall-Stockwell Company.
Egg whites, frozen, .	1,230	June 21, 1917	Jan. 1, 1919[1]	Goldsmith-Wall-Stockwell Company.
Egg whites, frozen, .	2,400	June 22, 1917	Jan. 1, 1919[1]	Goldsmith-Wall-Stockwell Company.
Egg whites, frozen, .	570	June 23, 1917	Jan. 1, 1919[1]	Goldsmith-Wall-Stockwell Company.
Egg whites, frozen, .	1,530	June 25, 1917	Jan. 1, 1919[1]	Goldsmith-Wall-Stockwell Company.
Egg whites, frozen, .	780	June 27, 1917	Jan. 1, 1919[1]	Goldsmith-Wall-Stockwell Company.
Butter, ...	100	May 28, 1917	Dec. 28, 1918	Cutter, George F.
Butter, ...	120	June 11, 1917	Sept. 15, 1918	Fowle, Hibbard Company.
Butter, ...	180	June 11, 1917	Sept. 15, 1918	Fowle, Hibbard Company.
Butter, ...	120	July 24, 1917	Nov. 1, 1918	Industrial School for Crippled and Deformed Children.
Butter, ...	671	May 7, 1917	Sept. 1, 1918	Lewis, Mears Company.
Butter, ...	308	July 12, 1917	Oct. 15, 1918	Normal Hall, Plymouth, N. H.
Butter, ...	1,140	Aug. 14, 1917	Nov. 1, 1918	Richardson, Harry T. B.
Butter, ...	2,400	July 2, 1917	Dec. 1, 1918	St. John's Preparatory School.
Butter, ...	1,080	July 2, 1917	Dec. 1, 1918	St. John's Preparatory School.
Butter, ...	360	Aug. 14, 1917	Sept. 14, 1918	Wilfert, George H., & Co.
Butter, ...	1,200	July 27, 1917	Jan. 27, 1919	Worcester Market.
Butterine, ...	180	Aug., 1917	Sept. 14, 1918	Union Training School.
Broilers, ...	98	Dec. 2, 1916	Jan. 2, 1918	Borst, Pierce Company.
Broilers, ...	483	Dec. 2, 1916	Jan. 2, 1918	Borst, Pierce Company.
Broilers, ...	653	Dec. 2, 1916	Apr. 2, 1918	Borst, Pierce Company.

[1] Extension granted to this date in accordance with request of Food Administration.

TABLE 3. — *Requests for Extension of Time granted from Dec. 1, 1917, to Dec. 1, 1918, on Goods in Cold Storage* — Continued.

ARTICLE.	Weight (Pounds).	Placed in Storage.	Extension granted to —	Name.
Broilers, ...	166	Dec. 2, 1916	Jan. 2, 1918	Borst, Pierce Company.
Broilers, ...	456	Dec. 11, 1916	Jan. 11, 1918	Borst, Pierce Company.
Broilers, ...	954	Dec. 11, 1916	Jan. 11, 1918	Borst, Pierce Company.
Broilers, ...	65	Dec. 26, 1916	Jan. 26, 1918	Borst, Pierce Company.
Broilers, ...	67	Dec. 26, 1916	Jan. 26, 1918	Borst, Pierce Company.
Broilers, ...	222	Dec. 26, 1916	Jan. 26, 1918	Borst, Pierce Company.
Broilers, ...	486	Dec. 26, 1916	Jan. 26, 1918	Borst, Pierce Company.
Broilers, ...	498	Jan. 3, 1917	Feb. 3, 1918	Borst, Pierce Company.
Broilers, ...	328	Jan. 13, 1917	Feb. 13, 1918	Borst, Pierce Company.
Broilers, ...	219	Jan. 13, 1917	Feb. 13, 1918	Borst, Pierce Company.
Broilers, ...	1,083	Jan. 13, 1917	Feb. 13, 1918	Borst, Pierce Company.
Broilers, ...	140	Jan. 3, 1917	Apr. 3, 1918	Borst, Pierce Company.
Broilers, ...	361	Jan. 3, 1917	Apr. 3, 1918	Borst, Pierce Company.
Broilers, ...	264	Dec. 11, 1916	Apr. 11, 1918	Borst, Pierce Company.
Broilers, ...	222	Dec. 11, 1916	Apr. 11, 1918	Borst, Pierce Company.
Broilers, ...	226	Dec. 11, 1916	Apr. 11, 1918	Borst, Pierce Company.
Broilers, ...	309	Dec. 26, 1916	Apr. 26, 1918	Borst, Pierce Company.
Broilers, ...	790	Dec. 26, 1916	Apr. 26, 1918	Borst, Pierce Company.
Broilers, ...	270	Oct. 13, 1916	Mar. 19, 1918	Eastman, Frank B.
Broilers, ...	280	Oct. 13, 1916	Mar. 19, 1918	Eastman, Frank B.
Broilers, ...	156	Dec. 5, 1916	Jan. 1, 1918	Radlo Brothers Company.
Broilers, ...	332	Dec. 5, 1916	Jan. 1, 1918	Radlo Brothers Company.
Broilers, ...	195	Dec. 6, 1916	Jan. 1, 1918	Radlo Brothers Company.
Broilers, ...	926	Dec. 30, 1916	Feb. 1, 1918	Radlo Brothers Company.
Broilers, ...	734	Nov., 1916	Apr. 23, 1918	Robbins, Nathan Company.
Broilers, ...	2,003	Nov., 1916	Apr. 23, 1918	Robbins, Nathan Company.
Broilers, ...	3,517	Nov., 1916	May 15, 1918	Robbins, Nathan Company.
Capons, ...	153	Dec. 16, 1916	Apr. 16, 1918	Borst, Pierce Company.
Capons, ...	1,932	Feb. 13, 1917	Mar. 13, 1918	Lamson & Co.
Capons, ...	450	Feb. 17, 1917	Mar. 17, 1918	Lamson & Co.
Capons, ...	2,306	Mar. 2, 1917	Apr. 2, 1918	Lamson & Co.
Capons, ...	1,800	Feb. 17, 1917	June 17, 1918	Lamson & Co.
Capons, ...	1,677	Feb. 23, 1917	June 23, 1918	Lamson & Co.
Capons, ...	1,312	Feb. 26, 1917	June 26, 1918	Lamson & Co.
Capons, ...	3,333	Feb. 9, 1917	Mar. 9, 1918	Legg, G. M. D., Company.
Capons, ...	4,354	Feb. 12, 1917	June 12, 1918	Legg, G. M. D., Company.

TABLE 3. — *Requests for Extension of Time granted from Dec. 1, 1917, to Dec. 1, 1918, on Goods in Cold Storage* — Continued.

Article.	Weight (Pounds).	Placed in Storage.	Extension granted to —	Name.
Capons, ...	740	Jan. 27, 1917	Mar. 1, 1918	Radlo Brothers Company.
Capons, ...	3,852	Jan. 29, 1917	Mar. 1, 1918	Radlo Brothers Company.
Capons, ...	1,713	Feb. 2, 1917	June 2, 1918	Wilcox, Charles A., & Co.
Chickens, . . .	1,571	Dec. 11, 1916	Jan. 11, 1918	Borst, Pierce Company.
Chickens, . . .	1,979	Dec. 11, 1916	Jan. 11, 1918	Borst, Pierce Company.
Chickens, . . .	471	Dec. 26, 1916	Jan. 26, 1918	Borst, Pierce Company.
Chickens, . . .	4,418	Dec. 11, 1916	Apr. 11, 1918	Borst, Pierce Company.
Chickens, . . .	4,418	Dec. 26, 1916	Apr. 26, 1918	Borst, Pierce Company.
Chickens, . . .	2,739	Dec. 26, 1916	Jan. 26, 1918	Borst, Pierce Company.
Chickens, . . .	420	Jan. 11, 1917	Feb. 3, 1918	Borst, Pierce Company.
Chickens, . . .	994	Jan. 13, 1917	Feb. 13, 1918	Borst, Pierce Company.
Chickens, . . .	2,253	Jan. 13, 1917	May 13, 1918	Borst, Pierce Company.
Chickens, . . .	696	Feb. 15, 1917	Mar. 27, 1918	Brockton Public Market.
Chickens, . . .	576	Feb. 15, 1917	Mar. 27, 1918	Brockton Public Market.
Chickens, . . .	355	Dec. 29, 1916	Jan. 29, 1918	Corwin, C. R., Company.
Chickens, . . .	410	Dec. 29, 1916	Apr. 4, 1918	Corwin, C. R., Company.
Chickens, . . .	30	Nov. 10, 1917	Jan. 10, 1919	Croker, Joseph B.
Chickens, . . .	581	Dec. 2, 1916	Feb. 1, 1918	Radlo Brothers Company.
Chickens, . . .	1,028	Dec. 2, 1916	Jan. 1, 1918	Radlo Brothers Company.
Chickens, . . .	840	Dec. 11, 1916	Feb. 11, 1918	Wilcox, Charles A., Company.
Chickens, . . .	440	Dec. 11, 1916	Feb. 11, 1918	Wilcox, Charles A., Company.
Chickens, . . .	886	Dec. 11, 1916	Feb. 11, 1918	Wilcox, Charles A., Company.
Chickens, . . .	2,332	Dec. 22, 1916	Mar. 22, 1918	Wilcox, Charles A., Company.
Chickens, . . .	1,378	Jan. 2, 1917	Apr. 2, 1918	Wilcox, Charles A., Company.
Chickens (Guinea), .	991	Dec. 2, 1916	Apr. 2, 1918	Batchelder & Snyder Company.
Chickens (Guinea), .	700	Jan. 10, 1917	Mar. 1, 1918	Dorr, Arthur E., & Co., Inc.
Chickens (Guinea), .	2,843	Dec. 14, 1916	Apr. 14, 1918	Wilcox, Charles A., Company.
Chickens (Guinea), .	554	Feb. 1, 1917	Mar. 1, 1918	Wilcox, Charles A., Company.
Fowl, ...	688	Dec. 2, 1916	Jan. 2, 1918	Borst, Pierce Company.
Fowl, ...	1,000	Dec. 2, 1916	Apr. 2, 1918	Borst, Pierce Company.
Fowl, ...	204	Dec. 11, 1916	Jan. 11, 1918	Borst, Pierce Company.
Fowl, ...	104	Dec. 26, 1916	Jan. 26, 1918	Borst, Pierce Company.
Fowl, ...	778	Jan. 3, 1917	Apr. 3, 1918	Borst, Pierce Company.
Fowl, ...	287	Jan. 13, 1917	Feb. 13, 1918	Borst, Pierce Company.
Fowl, ...	630	Nov. 23, 1916	Apr. 10, 1918	Brockton Public Market.
Fowl, ...	35	Nov. 23, 1916	Apr. 10, 1918	Brockton Public Market.

TABLE 3. — *Requests for Extension of Time granted from Dec. 1, 1917, to Dec. 1, 1918, on Goods in Cold Storage* — Continued.

ARTICLE.	Weight (Pounds).	Placed in Storage.	Extension granted to —	Name.
Fowl,	48	Nov. 23, 1916	Apr. 10, 1918	Brockton Public Market.
Geese, green,	1,030	Dec. 4, 1916	Jan. 4, 1918	Robbins, Nathan, Company.
Geese, green,	976	Dec. 26, 1916	Jan. 26, 1918	Robbins, Nathan, Company.
Geese, green,	3,485	Dec. 11, 1916	Apr. 4, 1918	Robbins, Nathan, Company.
Poultry,	1,140	Dec. 4, 1916	Apr. 1, 1918	Malatesta, Joseph.
Poultry,	1,143	Dec. 2, 1916	Feb. 1, 1918	Radlo Brothers Company.
Poultry,	697	Dec. 22, 1916	Feb. 1, 1918	Radlo Brothers Company.
Poultry,	204	Dec. 23, 1916	Feb. 1, 1918	Radlo Brothers Company.
Poultry,	225	Nov. 26, 1916	Dec. 28, 1917	Soracco, T., & Co.
Poultry,	400	Dec. 2, 1916	Jan. 2, 1918	Soracco, T., & Co.
Poultry,	44	Dec. 2, 1916	Dec. 28, 1917	Soracco, T., & Co.
Poultry,	629	Nov. 23, 1916	Apr. 1, 1918	Wilfert, George H., & Co.
Turkeys,	4,057	Dec. 5, 1916	Dec. 20, 1917	Borst, Pierce Company.
Turkeys,	1,330	Dec. 1, 1916	Jan. 1, 1918	Handy, H. L., Company.
Turkeys,	1,320	Dec. 1, 1916	Jan. 1, 1918	Handy, H. L., Company.
Turkeys,	390	Dec. 1, 1916	Jan. 1, 1918	Handy, H. L., Company.
Turkeys,	784	Dec. 1, 1916	Jan. 1, 1918	Stevens, Genery, & Sons.
Squab,	450	Jan. 8, 1917	Mar. 8, 1918	Wilcox, Charles A., Company.
Deer,	125	Nov. 12, 1917	Jan. 12, 1919	Faust, H. M.
Rabbits,	8,300	Oct. 22, 1917	Dec. 22, 1918	Samuel Holmes, Inc.
Beef, frozen,	375,000	Nov. 23, 1917	Feb. 5, 1919	Burns, P., & Co., Ltd.
Beef chucks,	440	Unknown.	Sept. 16, 1918	Eastern Cold Storage Company.
Beef, Hamburg,	75	Aug. 25, 1917	Sept. 16, 1918	Eastern Cold Storage Company.
Beef livers,	2,648	Sept. 21, 1917	Oct. 21, 1918	Baker Brokerage Company.
Beef tongues,	14,568	July 1, 1917	Sept. 1, 1918	Chamberlain & Co.
Lamb,	56	June 20, 1917	Sept. 16, 1918	Eastern Cold Storage Company.
Lamb,	100	July 31, 1917	Aug. 31, 1918	Harvard Provision Company.
Lamb fores,	3,142	Oct. 23, 1917	Dec. 23, 1918	Dorr, Arthur E., & Co., Inc.
Mutton,	120	June 11, 1917	Sept. 16, 1918	Eastern Cold Storage Company.
Pork,	25	July 27, 1917	Sept. 16, 1918	Eastern Cold Storage Company.
Sausage,	25	Aug. 21, 1917	Sept. 16, 1918	Eastern Cold Storage Company.
Sweetbreads,	45	Unknown.	Sept. 16, 1918	Eastern Cold Storage Company.
Veal,	100	Aug. 10, 1917	Sept. 16, 1918	Eastern Cold Storage Company.
Lobster,	100	June 5, 1917	June 25, 1918	Commonwealth Ice and Cold Storage Company.
Salmon,	13,200	Jan. 4, 1917	Feb. 8, 1918	Booth Fisheries Company.
Smelts,	1,800	Nov. 6, 1917	Jan. 6, 1919	Foley, M. F., Company.

TABLE 3.—*Requests for Extension of Time granted from Dec. 1, 1917, to Dec. 1, 1918, on Goods in Cold Storage*—Concluded.

ARTICLE.	Weight (Pounds).	Placed in Storage.	Extension granted to—	Name.
Shrimp,	200	Nov. 19, 1917	Dec. 19, 1918	Union Lobster Company.
Squid,[1]	800	July 21, 1917	Apr. 1, 1919	Atwood & Co.
Squid,[1]	550	Aug. 2, 1917	Apr. 1, 1919	Atwood & Co.
Squid,[1]	1,800	Aug. 10, 1917	Apr. 1, 1919	Atwood & Co.
Squid,[1]	1,175	July 19, 1917	Aug. 30, 1918	Mantia, John.
Squid,[1]	1,800	July 20, 1917	Aug. 30, 1918	Mantia, John.
Squid,[1]	1,600	Oct. 30, 1917	Dec. 1, 1918	Prevoir, Frank.

[1] To be used for bait.

TABLE 4.—*Requests for Extension of Time not granted from Dec. 1, 1917, to Dec. 1, 1918, on Goods in Cold Storage.*

ARTICLE.	Weight (Pounds).	Placed in Storage.	Permission to remove.	Name.
Eggs, canned,	1,320	Aug. 4, 1917	Aug. 4, 1918	Poole, J. R., Company.
Butter,	183	July 5, 1917	July 22, 1918	Doe, Sullivan & Co., Inc.
Butter,	62	July 12, 1917	July 22, 1918	Doe, Sullivan & Co., Inc.
Butter,	6,820	June 27, 1917	June 27, 1918	Ellis, J. R., & Sons.
Butter,	900	Aug. 1, 1917	June 13, 1918[1]	Holderness School.
Butter,	1,116	July 3, 1917	July 3, 1918	Klink, Carl C.
Butter,	2,100	May 24, 1917	May 24, 1918	Samoset Chocolate Company.
Broilers,	118	Dec. 2, 1916	Dec. 8, 1917	Borst, Pierce Company.
Broilers,	235	Dec. 2, 1916	Dec. 8, 1917	Borst, Pierce Company.
Broilers,	88	Dec. 2, 1916	Dec. 11, 1917	Radlo Brothers Company.
Broilers,	570	Jan. 2, 1917	Jan. 11, 1918	Radlo Brothers Company.
Broilers,	317	Jan. 2, 1917	Jan. 11, 1918	Radlo Brothers Company.
Broilers,	619	Jan. 3, 1917	Jan. 11, 1918	Radlo Brothers Company.
Broilers,	125	Jan. 6, 1917	Jan. 11, 1918	Radlo Brothers Company.
Broilers,	284	Jan. 9, 1917	Jan. 11, 1918	Radlo Brothers Company.
Broilers,	2,215	Mar. 26, 1917	Apr. 13, 1918	Skinner, George E., Company.
Broilers,	350	Mar. 26, 1917	Apr. 13, 1918	Skinner, George E., Company.
Broilers,	944	Mar. 26, 1917	Apr. 13, 1918	Skinner, George E., Company.
Broilers,	977	Mar. 26, 1917	Apr. 13, 1918	Skinner, George E., Company.
Broilers,	1,629	Mar. 26, 1917	Apr. 13, 1918	Skinner, George E., Company.

[1] Request for extension was made before the year expired, as the school year terminated in June, but the butter was developing rancidity and was ordered out of storage.

TABLE 4. — *Requests for Extension of Time not granted from Dec. 1, 1917, to Dec. 1, 1918, on Goods in Cold Storage* — Concluded.

ARTICLE.	Weight (Pounds).	Placed in Storage.	Permission to remove.	Name.
Chickens, ...	1,175	Dec. 26, 1916	Dec. 28, 1917	Borst, Pierce Company.
Poultry, ...	280	Nov. 24, 1916	Dec. 8, 1917	Soracco, T., & Co.
Beef breads, . . .	570	Mar. 28, 1917	Apr. 10, 1918	Dorr, Arthur E., & Co., Inc.
Beef loins, . . .	467	Apr. 10, 1917	Apr. 10, 1918	Sturtevant & Haley.
Mutton, ...	1,032	June 7, 1917	June 28, 1918	Blackstone Supply Company.
Mutton, ...	3,393	June 6, 1917	June 28, 1918	Blackstone Supply Company.
Mutton, ...	391	June 8, 1917	June 28, 1918	Blackstone Supply Company.
Sweetbreads, . . .	72	Apr. 13, 1917	Apr. 13, 1918	Kittredge, R. H.
Veal sweetbreads, . .	170	Apr. 13, 1917	Apr. 10, 1918	Barker, H. H.
Jowls, ...	3,750	Mar. 26, 1917	Apr. 10, 1918	Re, Abraham.
Skate fins, . . .	1,202	May 29, 1917	June 13, 1918	Boston Fish Pier Company.
Sole, ...	8,000	June 12, 1917	June 25, 1918	Burns, John, Company.

TABLE 5. — *Requests granted from Dec. 1, 1917, to Dec. 1, 1918, for Permission to remove Articles which had been in Cold Storage longer than Twelve Months.*

ARTICLE.	Weight (Pounds).	Placed in Storage.	Permission to remove.	Name.
Eggs, canned, . . .	-	Oct. 23, 1916	Jan. 21, 1918	Quincy Market Cold Storage and Warehouse Company.
Eggs, canned, . . .	-	Aug. 28, 1916	Jan. 21, 1918	Quincy Market Cold Storage and Warehouse Company.
Eggs, canned, . . .	-	Oct. 2, 1916	Jan. 21, 1918	Quincy Market Cold Storage and Warehouse Company.
Butter, ...	60	July 5, 1917	July 23, 1918	Fales, George A.
Butter, ...	300	July 5, 1917	July 23, 1918	Fales, George A.
Butter, ...	186	July 19, 1917	Aug. 12, 1918	Green & Co.
Butter, ...	30	June 13, 1917	Aug. 1, 1918	Smith Brothers.
Butter, ...	80	June 5, 1917	Aug. 1, 1918	Smith Brothers.
Butter, ...	20	Aug. 9, 1917	Nov. 21, 1918	Stone, C. H.
Butterine, ...	600	June 20, 1917	Aug. 1, 1918	Smith Brothers.
Broilers, ...	213	Dec. 1, 1916	Apr. 15, 1918	Boston Terminal Refrigerating Company.
Capons, ...	64	Jan. 22, 1917	Feb. 25, 1918	Dorr, Arthur E., & Co., Inc.
Chickens, ...	320	Dec. 1, 1916	Dec. 21, 1917	Benks, A. P., Company.
Chickens, ...	172	Dec. 5, 1916	Apr. 15, 1918	Boston Terminal Refrigerating Company.
Chickens, ...	62	Dec. 19, 1916	Apr. 15, 1918	Boston Terminal Refrigerating Company.
Chickens, ...	65	Dec. 11, 1916	Apr. 15, 1918	Boston Terminal Refrigerating Company.
Chickens, ...	175	Jan. 25, 1917	Feb. 22, 1918	Kirsch, F. H.

TABLE 5. — *Requests granted from Dec. 1, 1917, to Dec. 1, 1918, for Permission to remove Articles which had been in Cold Storage longer than Twelve Months* — Concluded.

ARTICLE.	Weight (Pounds).	Placed in Storage.	Permission to remove.	Name.
Chickens,	140	May 9, 1917	Feb. 6, 1918	Strong, Marson Company.
Fowl,	25	Dec. 1, 1916	Apr. 15, 1918	Boston Terminal Refrigerating Company.
Fowl,	250	Dec. 1, 1916	Apr. 15, 1918	Boston Terminal Refrigerating Company.
Fowl,	601	Dec. 4, 1916	Apr. 15, 1918	Boston Terminal Refrigerating Company.
Fowl,	724	Jan. 25, 1917	Feb. 28, 1918	Hutchinson, W. K., Company.
Poultry,	50	Nov. 25, 1916	Dec. 14, 1917	Borst, Pierce Company.
Poultry,	87	-	Apr. 15, 1918	Boston Terminal Refrigerating Company.
Poultry,	804	Dec. 15, 1916	Apr. 15, 1918	Boston Terminal Refrigerating Company.
Poultry,	65	Aug. 29, 1917	Nov. 21, 1918	Eastern Cold Storage Company.
Poultry,	185	Dec. 5, 1916	Dec. 8, 1917	McCabe, M. J., Company.
Turkeys,	216	Dec. 8, 1916	Apr. 15, 1918	Boston Terminal Refrigerating Company.
Turkeys,	232	Dec. 22, 1916	Apr. 15, 1918	Boston Terminal Refrigerating Company.
Venison,	20	Nov. 25, 1915	Feb. 15, 1918	Boyden, George W.
Venison,	7[1]	-	Mar. 30, 1918	Killelea, P. H.
Venison,	7[1]	-	Mar. 30, 1918	Killelea, P. H.
Beef butts,	52	Dec. 12, 1916	Apr. 15, 1918	Boston Terminal Refrigerating Company.
Beef butts,	200	Aug. 4, 1917	Oct. 29, 1918	Boston Terminal Refrigerating Company.
Beef legs,	150	Oct. 5, 1917	Oct. 29, 1918	Boston Terminal Refrigerating Company.
Beef loins,	417	June 8, 1917	Dec. 2, 1918	Union Supply Company.
Beef ribs,	790	May 22, 1917	June 13, 1918	Batchelder & Snyder Company.
Beef rolls,	1,700	Aug. 4, 1917	Oct. 29, 1918	Boston Terminal Refrigerating Company.
Ox tails,	500	May 21, 1917	Aug. 2, 1918	Goodenough & Russell.
Pork,	35	Sept. 6, 1917	Sept. 28, 1918	Harvard Provision Company.

[1] Pieces.

TABLE 6. — *Articles which had been in Cold Storage longer than Twelve Months, and on which no Requests for Extension had been made from Dec. 1, 1917, to Dec. 1, 1918, ordered removed.*

ARTICLE.	Weight (Pounds).	Placed in Storage.	Directed to remove.	Name.
Eggs,	300	Aug. 9, 1917	Aug. 22, 1918	Goldsmith-Wall-Stockwell Company.
Egg yolks,	1,980	July 27, 1917	Sept. 6, 1918	Poole, J. R., Company.
Butter,	1,115	June 14, 1917	July 19, 1918	Crosby Brothers Company.

TABLE 6. — *Articles which had been in Cold Storage longer than Twelve Months, and on which no Requests for Extension had been made from Dec. 1, 1917, to Dec. 1, 1918, ordered removed* — Continued.

ARTICLE.	Weight (Pounds).	Placed in Storage.	Directed to remove.	Name.
Butter, ...	100	July 30, 1917	Aug. 9, 1918	Curtis & Roberts.
Butter, ...	60	Oct. 18, 1916	July 29, 1918	Eastern Cold Storage Company.
Butter, ...	150	Aug. 31, 1917	Sept. 21, 1918	Fairmont Creamery Company.
Butter, ...	1,500	Aug. 17, 1917	Sept. 30, 1918	Green & Co.
Butter, ...	40	July 12, 1917	July 29, 1918	Musgrave, G. H.
Butter, ...	45	July 13, 1917	July 29, 1918	Plymouth Creamery Company.
Butter, ...	20	Aug. 28, 1917	Sept. 21, 1918	Stone, C. H., & Co.
Butter, ...	30	Aug. 3, 1917	Aug. 15, 1918	Tibbetts, Nellie M.
Butter, ...	30	June 9, 1917	July 29, 1918	Wilfert, George.
Broilers, ...	925	Dec. 9, 1916	Jan. 11, 1918	Armour & Co.
Broilers, ...	248	Dec. 23, 1916	Jan. 10, 1918	Armour & Co.
Broilers, ...	1,430	Mar. 2, 1918	Mar. 29, 1918	Childs, Sleeper & Co.[1]
Broilers, ...	43	June 8, 1917	Aug. 9, 1918	Eastern Cold Storage Company.
Broilers, ...	128	Dec. 1, 1916	Jan. 18, 1918	Kirsch, F. H., & Co.
Broilers, ...	88	Dec. 2, 1916	Dec. 11, 1917	Radlo Brothers Company.
Broilers, ...	120	Aug. 11, 1917	Nov. 18, 1918	Wilcox, C. A.
Chickens, ...	224	Dec. 9, 1916	Jan. 11, 1918	Armour & Co.
Chickens, ...	3,012	Dec. 26, 1916	Jan. 18, 1918	Armour & Co.
Chickens, ...	110	Dec. 26, 1916	Jan. 18, 1918	Armour & Co.
Chickens, ...	40	Dec. 16, 1916	Jan. 25, 1918	Borst, Pierce Company.
Chickens, ...	504	Dec. 30, 1916	Jan. 18, 1918	Dorr, Arthur E., & Co., Inc.
Chickens, ...	320	Dec. 16, 1916	Feb. 20, 1918	English Tea Room.
Chickens, ...	156	Dec. 4, 1916	Feb. 12, 1918	Harvard Club of Boston.
Chickens, ...	294	Jan. 11, 1917	Feb. 12, 1918	Harvard Club of Boston.
Chickens, ...	861	Jan. 25, 1917	Feb. 12, 1918	Harvard Club of Boston.
Chickens, ...	175	Dec. 22, 1916	Feb. 12, 1918	Harvard Club of Boston.
Chickens, ...	50	Oct. 1, 1917	Nov. 18, 1918	Stroug, Marson Company.
Chickens (Guinea), .	55	July 18, 1917	Oct. 24, 1918	Eastern Cold Storage Company.
Chickens (Guinea), .	39	Aug. 15, 1917	Sept. 12, 1918	Rodman, B. W.
Chickens, ...	180	Apr. 30, 1917	Aug. 9, 1918	Eastern Cold Storage Company.
Ducks, ...	257	Jan. 3, 1917	Jan. 25, 1918	Gunsenheiser, A., & Co.
Fowl, ...	70	Nov. 22, 1916	Jan. 29, 1918	Batchelder & Snyder Company.
Fowl, ...	38	May 18, 1917	June 13, 1918	Harvard Provision Company.
Fowl, ...	92	Nov. 16, 1916	Dec. 2, 1918	Spaulding, F. W.

[1] This lot had previously been stored in another warehouse.

TABLE 6. — *Articles which had been in Cold Storage longer than Twelve Months, and on which no Requests for Extension had been made from Dec. 1, 1917, to Dec. 1, 1918, ordered removed* — Continued.

ARTICLE.	Weight (Pounds).	Placed in Storage.	Directed to remove.	Name.
Poultry, ...	397	Dec. 7, 1916	Jan. 11, 1918	Armour & Co.
Poultry, ...	–	Dec. 28, 1917	Jan. 18, 1918	Armour & Co.[1]
Poultry, ...	–	Dec. 28, 1917	Jan. 18, 1918	Armour & Co.[1]
Poultry, ...	63	Dec. 29, 1916	Jan. 16, 1918	White, Tucker Company.
Roosters, . . .	35	July 5, 1917	Oct. 24, 1918	Panley, George.
Squab, ...	–	Sept. 29, 1917	Nov. 15, 1918	Poole, William H.
Turkeys (boxes), . .	4	Dec. 8, 1916	Dec. 13, 1917	Bowles, J. C.
Turkeys (boxes), . .	4	Dec. 8, 1916	Dec. 13, 1917	Bowles, J. C.
Turkeys, ...	600	Dec. 18, 1916	Dec. 26, 1917	Cooper, J. G.
Turkeys, ...	402	Nov. 28, 1916	Dec. 8, 1917	Cudahy Packing Company.
Turkeys, ...	3,800	Nov. 28, 1916	Dec. 8, 1917	Dorr, Arthur E., & Co., Inc.
Turkeys (barrels), . .	36	Jan. 3, 1917	Dec. 17, 1917	Flynn's Market.[1]
Turkeys (barrels), . .	11	–	Dec. 17, 1917	Morgan, J. G., & Co.[1]
Turkeys, ...	186	July 3, 1917	Aug. 2, 1918	Strong, Marson Company.
Game, ...	40	Jan. 30, 1917	Feb. 13, 1918	Robinson, H. C.
Game, ...	100	Jan. 3, 1917	Jan. 25, 1918	Savage, H. M.
Venison, ...	53	Nov. 1, 1917	Nov. 18, 1918	Day, C. S., Company.
Venison, ...	30	–	Jan. 11, 1918	Fyfe, R. M. J.
Beef, ...	315	Apr. 23, 1917	May 23, 1918	St. Botolph Club.
Beef briskets, . . .	180	Jan. 10, 1917	Jan. 30, 1918	Jacobson, S.
Beef butts, . . .	50	Aug. 4, 1917	Sept. 12, 1918	Dempsey, J. F.
Beef faces, . . .	750	Oct. 10, 1917	Nov. 18, 1918	Chamberlain & Co.
Beef faces, . . .	118	Oct. 3, 1917	Nov. 18, 1918	Thorndike & Stolar.
Beef, Hamburg, . .	120	July 10, 1917	Aug. 2, 1918	Blackstone Supply Company.
Beef livers, . . .	292	Oct. 5, 1917	Oct. 24, 1918	Clinton Market and Provision Company.
Beef livers, . . .	127	Sept. 18, 1917	Oct. 10, 1918	Curtis & Roberts.
Beef livers, . . .	203	Aug. 31, 1917	Oct. 24, 1918	Kelley, J. J., Company.
Beef livers, . . .	328	Sept. 16, 1917	Sept. 28, 1918	Kelley, J. J., Company.
Beef livers, . . .	1,474	Sept. 18, 1917	Oct. 10, 1918	Pelletier, G. J.
Beef livers, . . .	290	Sept. 18, 1917	Oct. 10, 1918	Prince, C. M., & Son.
Beef loins (bundles), .	14	Apr. 13, 1917	Aug. 1, 1918	Keyes Supply Company.
Beef loins, . . .	891	Apr. 13, 1917	Aug. 1, 1918	Keyes Supply Company.
Beef loins, . . .	240	July 12, 1917	Oct. 24, 1918	Lexington Trust Company.
Beef loins, . . .	460	Aug. 15, 1917	Sept. 12, 1918	Union Supply Company.

[1] Had previously been stored in another warehouse.

TABLE 6. — *Articles which had been in Cold Storage longer than Twelve Months, and on which no Requests for Extension had been made from Dec. 1, 1917, to Dec. 1, 1918, ordered removed* — Continued.

ARTICLE.	Weight (Pounds).	Placed in Storage.	Directed to remove.	Name.
Beef rolls,	780	Aug. 7, 1917	Sept. 12, 1918	Wattendorf, G. V.
Beef tenderloins,	394	Aug. 13, 1917	Aug. 26, 1918	Thorndike & Stolar.
Beef tenderloins,	213	Aug. 13, 1917	Aug. 26, 1918	Thorndike & Stolar.
Beef tenderloins,	20	Sept. 7, 1917	Sept. 28, 1918	Thorndike & Stolar.
Beef tenderloins,	200	June 9, 1917	Aug. 1, 1918	Wilkins, D. G., Company.
Lamb,	165	Sept. 5, 1917	Sept. 28, 1918	Blackstone Supply Company.
Lamb,	453	Sept. 5, 1917	Sept. 28, 1918	Blackstone Supply Company.
Lamb.	350	May 29, 1917	July 6, 1918	Dolan, W. J.
Lamb,	60	June 5, 1917	Aug. 2, 1918	Eastern Cold Storage Company.
Lamb,	121	Aug. 7, 1917	Oct. 21, 1918	Eastern Cold Storage Company.
Lamb,	84	June 26, 1917	Sept. 18, 1918	John, Peter.
Lamb,	152	July 6, 1917	Sept. 18, 1918	Rodman, B. W.
Lamb,	150	July 5, 1917	Sept. 18, 1918	Thorndike & Stolar.
Lamb,	810	June 8, 1917	Aug. 1, 1918	Wattendorf, G. V.
Lamb chops,	50	Aug. 6, 1917	Nov. 18, 1918	Brown, C. E.
Lamb chops,	55	Oct. 1, 1917	Nov. 18, 1918	Strong, Marson Company.
Lamb fores,	20	Nov. 6, 1917	Nov. 25, 1918	Johnson, C.
Mutton,	133	Apr. 12, 1917	May 23, 1918	Blackstone Supply Company.
Mutton,	137	July 24, 1917	Aug. 24, 1918	Eastern Cold Storage Company.
Mutton fores,	194	Nov. 23, 1916	Feb. 13, 1918	Bay State Fisheries Company.
Mutton legs,	98	Aug. 22, 1917	Sept. 12, 1918	Union Supply Company.
Ox tails,	40	May 2, 1917	Aug. 1, 1918	Strong, Marson Company.
Ox tails,	56	July 5, 1917	Oct. 24, 1918	Sturtevant & Haley.
Pigs' ears and feet,	116	Oct. 4, 1917	Nov. 18, 1918	Huntley, R. J.
Pigs' feet,	300	Aug. 14, 1917	Nov. 29, 1918	Fay & O'Conner.
Pigs' feet,	3,000	July 18, 1917	Aug. 9, 1918	Dolan, Walter J.
Pork (spare ribs),	3,000	Jan. 25, 1917	Nov. 25, 1918	Blackstone Supply Company.
Pork,	55	Jan. 16, 1917	Feb. 22, 1918	Rodman, B. W.
Pork livers,	500	Aug. 15, 1917	Sept. 7, 1918	Dolan, Walter J.
Pork loins,	700	July 12, 1917	Aug. 2, 1918	Blackstone Supply Company.
Sweetbreads,	12	Apr. 27, 1917	June 5, 1918	Kittredge, R. H.
Sweetbreads,	20	Apr. 14, 1917	May 23, 1918	Thorndike & Stolar.
Sweetbreads,	30	Apr. 14, 1917	May 23, 1918	Thorndike & Stolar.
Sweetbreads,	30	Apr. 14, 1917	May 23, 1918	Thorndike & Stolar.
Sweetbreads,	42	Apr. 14, 1917	May 23, 1918	Thorndike & Stolar.

TABLE 6. — *Articles which had been in Cold Storage longer than Twelve Months, and on which no requests for Extension had been made from Dec. 1, 1917, to Dec. 1, 1918, ordered removed* — Concluded.

ARTICLE.	Weight (Pounds).	Placed in Storage.	Directed to remove.	Name.
Veal,	125	Aug. 8, 1917	Aug. 21, 1918	Armour & Co.
Veal,	4,188	Apr. 11, 1917	May 23, 1918	Blackstone Supply Company.
Veal,	1,615	Apr. 18, 1917	May 23, 1918	Blackstone Supply Company.
Veal livers,	199	Oct. 4, 1917	Oct. 29, 1918	Dorr, Arthur E., & Co., Inc.
Bones,	188	Oct. 21, 1917	Dec. 2, 1918	Spinney, W. J.
Crab claws,	200	Nov. 7, 1916	Jan. 11, 1918	Dewildt, L.
Crab claws,	100	Nov. 29, 1916	Jan. 11, 1918	Dewildt, L.
Halibut,	900	June 2, 1917	June 13, 1918	Atlantic & Pacific Fish Company.
Halibut and salmon,	220	June 2, 1917	June 13, 1918	Atlantic & Pacific Fish Company.
Halibut,	621	Nov. 12, 1917	Nov. 22, 1918	Rush Fish Company.
Herring, small,	700	Nov. 12, 1917	Nov. 22, 1918	Atwood & Co.
Mackerel,	3,146	Oct. 22, 1917	Nov. 22, 1918	Burns, John, Company.
Mackerel,	1,100	Aug. 20, 1917	Sept. 7, 1918	Prevoir, Frank.
Sand eels,	650	Oct. 5, 1917	Oct. 24, 1918	Cefalu, J.
Sardine herring,	315	July 21, 1917	Aug. 14, 1918	Atkins, M.
Sardine herring,	770	Aug. 6, 1917	Aug. 22, 1918	Atkins, M.
Sardine herring,	105	Sept. 4, 1917	Sept. 30, 1918	Atkins, M.
Skatefish,	35	Aug. 3, 1917	Aug. 22, 1918	Cefalu, M.
Skate wings,	70	July 7, 1917	July 29, 1918	Cefalu, M.
Smelts,	105	June 2, 1917	June 13, 1918	Atlantic & Pacific Fish Company.
Squid,	9,200	Sept. 29, 1917	Oct. 24, 1918	Cefalu, M.
Squid,	2,360	Oct. 3, 1917	Oct. 24, 1918	Cefalu, M.
Squid,	14,600	Jan. 5, 1917	Aug. 1, 1918	Globe Fish Company.
Steak pollock,	845	Oct. 3, 1917	Oct. 18, 1918	Bookheim, William, & Sons.
Miscellaneous fish,	200	June 2, 1917	June 13, 1918	Atlantic & Pacific Fish Company.

Inspecting Slaughtering Statistics.

Table 7. — *Nominations for the Office of Inspector of Slaughtering, March 31, 1917, to Dec. 1, 1918.*

Number of nominations made by local boards of health,		482
Number of nominees approved by the State Department of Health,	470	
Number of nominees disapproved by the State Department of Health,	8	
Number of nominees upon which the State Department of Health took no action,	4	
Nominations made late in the year, still pending,		6
Cities and towns making no nominations,		8

Of the total number of nominations made, 48 were new nominees.
Of the nominees approved, 7 resigned and 2 died.
Of the nominees disapproved, 2 were reconsidered and approved.

Copies of licenses to slaughter granted by local boards of health and selectmen sent to this Department, ... 332

Table 8. — *Summary of Report on Inspection of Slaughtering.*

Total number of carcasses inspected,		166,698
Cattle,	29,219	
Calves,	78,156	
Hogs,	56,828	
Sheep,	2,479	
Goats,	16	
Total number of carcasses condemned,		2,240
Cattle,	535	
Calves,	1,411	
Hogs,	285	
Sheep,	9	
Total number of carcasses passed,		164,458

Reason for Condemnation.	Cattle.	Calves.	Hogs.	Sheep.	Totals.
Immaturity,	-	1,192	-	-	1,192
Tuberculosis,	444	12	102	2	560
Actinomycosis,	3	-	-	-	3
Pneumonia,	5	1	17	-	23
Pleurisy,	3	-	-	-	3
Hog cholera,	-	-	101	-	101
Gastritis,	1	-	-	-	1
Indigestion,	-	-	6	-	6
Enteritis,	1	-	2	-	3
Nephritis,	-	-	1	-	1
Inflammation,	2	-	-	-	2

Reason for Condemnation.	Cattle.	Calves.	Hogs.	Sheep.	Totals.
Nodular disease,	-	-	-	4	4
Peritonitis,	8	1	-	-	9
Cirrhosis of liver,	-	-	2	-	2
Necrosis of liver,	1	-	-	-	1
Icterus,	-	8	2	-	10
Diarrhœa,	-	16	-	-	16
Dysentery,	-	11	-	-	11
Abscesses,	3	-	4	-	7
Multiple abscesses,	-	-	1	-	1
Ulcers,	3	-	1	-	4
Abdominal ulcers,	-	-	1	-	1
Hemorrhage,	1	-	-	-	1
Septicæmia,	13	-	5	-	18
Pyæmia,	1	-	-	-	1
Eczema,	-	-	2	-	2
Chloasma,	-	-	3	-	3
Rheumatism,	-	-	1	-	1
Dropsy,	-	-	3	-	3
Fever,	1	-	-	-	1
Mammitis,	2	-	-	-	2
Parturient apoplexy,	-	-	1	-	1
Parturient paresis,	1	-	3	-	4
Difficult parturition,	2	-	-	-	2
Stillbirth,	-	4	-	-	4
Advanced pregnancy,	3	-	-	-	3
Metritis,	2	-	-	-	2
Emaciation,	5	39	10	-	54
Anæmia,	1	-	-	-	1
Cachexia,	-	49	-	-	49
Sexual odor,	-	-	1	-	1
Poisoning,	2	-	-	-	2
Lacerations,	-	8	-	-	8
Bruises,	9	17	1	-	27
Traumata,	5	5	4	2	16
Strangulation,	2	3	-	1	6
Improperly bled,	-	-	1	-	1
Inspector not present,	3	9	-	-	12
Died otherwise than by slaughter,	8	36	10	-	54
Totals,	535	1,411	285	9	2,240

DIVISION OF COMMUNICABLE DISEASES.

JOHN S. HITCHCOCK, M.D., *Director*.

REPORT OF DIVISION OF COMMUNICABLE DISEASES.

CHANGES IN ORGANIZATION.

The District Health Officer, the personal representative of the Commissioner of Health in his District, the convenient and authorized connecting link between the Department and local authorities, must of necessity be a generalist in public health matters. He not only advises local authorities as to general policies and measures but he has a mass of detail to attend to in the forty or more cities and towns in his District. The physical necessity of providing assistance for him was apparent. It was finally decided that a properly qualified Nursing Assistant would be of the most value. She could relieve him of many details and would be of especial value in the many activities among organizations of women who could be more effectively reached by a trained public health nurse than by a man, even though he were a physician. Accordingly a Nursing Assistant to each of the District Health Officers has been appointed.

These nurses had been in office but a very short time when the influenza outbreak appeared and the services they were able to render as organizers and inspectors in that emergency alone more than justified their appointment. Because of this outbreak there is nothing to report on their activities in the lines of work originally planned for them.

While the District Health Officer and the Nursing Assistant must be generalists, the volume of material coming to the office of the Department from the active anti-tuberculosis efforts in this State and from the newly awakened anti-venereal conscience of the military and the civil population made it apparent that office specialization along these lines was a requisite for any measure of success. Accordingly, two subdivisions have been established, — one for tuberculosis and one for the venereal diseases.

The Tuberculosis Subdivision keeps a file of all cases reported in the State, with a rather full report on each case collected from board of health, hospital, dispensary and District Health Officer records. This file is kept as closely up to date as possible and embodies the necessary information regarding the 20,000 or more active cases of tuberculosis, their probable source of infection, and the physical condition and movements of persons in dangerous contact with the case. The Chief

of the Subdivision and the Field Worker in co-operation with the District Health Officers and Nursing Assistants supervise dispensary procedures, records and the follow-up work in rural communities.

The Subdivision of Venereal Diseases is officered by a Chief, a male and a female Epidemiologist and an Educational Organizer. Reports of all cases come here, careless or incorrigible ones are referred back to their local health boards, State Approved Venereal Clinics are supervised, arsphenamine is distributed, and lectures and educational material are provided and distributed. In co-operation with military and civil organizations and with court officials, sources of infection are followed up and their treatment arranged for.

Changes in Personnel and Assignment.

Apr. 1. Dr. John S. Hitchcock appointed director of the Division of Communicable Diseases.

Apr. 1. Dr. Stanley H. Osborn, epidemiologist, entered the military service.

May 13. Dr. Bernard W. Carey of Fitchburg appointed epidemiologist.

June 1. Dr. Merrill E. Champion resigned as District Health Officer to become director of the Division of Hygiene.

June 1. Dr. Lyman A. Jones reappointed District Health Officer and assigned to the Northeastern Health District.

June 1. Dr. Russell B. Sprague of Brighton appointed District Health Officer and assigned to the Eastern Health District.

June 1. Dr. Arthur A. Brown, District Health Officer, transferred to the South Midland Health District.

June 1. Dr. George T. O'Donnell, District Health Officer, transferred to the Connecticut Valley Health District.

June 18. Mary F. Parker appointed assistant bacteriologist in the diagnostic laboratory.

Sept. 1. Dr. Adam S. MacKnight resigned as District Health Officer to become the Superintendent of the Bristol County Tuberculosis Hospital.

Sept. 1. Dr. Charles W. Milliken of Barnstable appointed District Health Officer and assigned to the Southeastern Health District.

Apr. 23. Mary E. Ayer appointed as nursing assistant and assigned to the Connecticut Valley Health District.

May 15. Cecelia A. Lemner appointed as nursing assistant and assigned to the Eastern Health District.

June 1. Mary C. Hoisington appointed as nursing assistant and assigned to the Berkshire Health District.

Sept. 1. Mildred F. Ashley appointed as nursing assistant and assigned to the North Midland Health District.

Sept. 1. Teresa V. Kelley appointed as nursing assistant and assigned to the Southeastern Health District.

Sept. 1. Maria G. Martin appointed as nursing assistant and assigned to the Wachusett Health District.

Sept. 8. Emily M. Rogers appointed as nursing assistant and assigned to the Northeastern Health District.

Sept. 15. Anna Hartnett appointed as nursing assistant and assigned to the South Midland Health District.

Subdivision of Tuberculosis.

Apr. 1. Miss Bernice W. Billings transferred from the Trustees of Hospitals for Consumptives. Appointed chief of subdivision of tuberculosis.

Sept. 14. Miss Medora M. Olmstead resigned as field worker.

Sept. 24. Miss Amy P. Churchill appointed as field worker.

Subdivision of Venereal Diseases.

June 1. Major Alec N. Thomson, M.C., U. S. A., detailed to act temporarily as chief of subdivision of venereal diseases.

June 20. Dr. Mary R. Lakeman appointed as epidemiologist.

Oct. 1. Dr. J. J. Carroll appointed as chief of the subdivision of venereal diseases.

Oct. 1. Dr. Lily O. Burbank appointed as educational organizer.

Epidemiologist (male) not yet appointed.

New Legislation, Acts of 1918, applying to this Division.

General Acts, chapter 58. To provide for the physical examination of inmates of penal institutions. Approved March 11, 1918.

General Acts, chapter 96. Relative to reports and records of venereal diseases. Approved March 26, 1918.

General Acts, chapter 111. Authorizing registered physicians and surgeons to disclose information pertaining to venereal diseases. Approved March 27, 1918.

General Acts, chapter 117. To make uniform physicians' certificates of exemption from vaccination. Approved March 27, 1918.

General Acts, chapter 130. Relative to the reporting of dangerous diseases by local boards of health to the State Department of Health, and its effect on reimbursement of towns for expenses. Approved April 2, 1918.

Special Acts, chapter 140. Appropriating $30,000 for the control, suppression and treatment of venereal diseases. Approved April 24, 1918.

General Acts, chapter 237. Relative to dissemination by advertisement of information concerning certain diseases, amending chapter 386, Acts of 1908. Approved May 28, 1918.

New Rules and Regulations affecting this Division.

Dec. 18, 1917. Gonorrhœa and syphilis, in an infectious stage, were added to the list of the diseases declared to be dangerous to the public health within the meaning of both chapter 670, Acts of 1913, and chapter 213, Acts of 1902.

Apr. 30, 1918. Contract between Hampden and Hampshire counties, providing for the care of tuberculous patients from Hampden County at the Hampshire County Sanatorium, approved.

May Bulletin. Official statement by the Commissioner as to persons and institutions entitled to receive information concerning venereal diseases.

May 21, 1918. Additional venereal disease regulation permitting immediate report by name of venereal cases.

July 8, 1918. Approval of specification of time and manner and form of blank for physical examination of prisoners.

Aug. 9, 1918. Suggested regulations for control of venereal diseases, including definition of "infectious stage," sent to boards of health.

Sept. 30, 1918. Influenza was added to the list of diseases declared dangerous to the public health under the provisions of chapter 670, Acts of 1913, and amendments.

In the year 1918 one great disease outbreak so occupied lay-people, physicians and health officials that ordinary routines went to pieces, and as a consequence the reporting of diseases dangerous to the public health was incomplete and unsatisfactory during the influenza epidemic months. As illustrative, it is hard to believe that typhoid fever, ordinarily at its highest point of incidence in the fall months, and occurring in 184 cases in August and 261 in September, really dropped to 97 cases in October and 48 in November, nor that true lobar pneumonia really did jump from 170 cases in August to 3,114 cases in September, and 3,817 in October, and that there were more cases in September and October than in all the rest of the year combined.

Our figures show, in the eleven most prevalent diseases which were reportable during both years, an increase in four and a decrease in the other seven. In measles, German measles and whooping cough this increase came through their general widespread prevalence during the first six months of the year. Lobar pneumonia was made reportable last year, and its ordinary rate of incidence has not been determined. The more complete reporting of cases in the second year would be expected to give us an increase, but not eight times as much, with over half of that increase bunched in two months. It is clear that much influenza broncho-pneumonia was reported as lobar pneumonia. We are fain to attribute the satisfactory decreases in the other common diseases, in part at least, to efforts at control. We have been trying in every way we could conceive to awaken in the public the sense of the preventability of communicable disease, and to urge them to apply their common sense to the problem. We feel that a 32 per cent decrease in diphtheria, a 30 per cent decrease in mumps, a 24 per cent decrease in scarlet fever, a 6 per cent decrease in pulmonary tuberculosis, and a 31 per cent decrease in typhoid fever, occurring in one and the same year, cannot all be either fortuitous or chargeable to carelessness in reporting during six weeks of a great influenza epidemic, but must be, at least in part, due to efforts at control.

The total volume of cases reported during the year was swelled to unprecedented size by the 145,000 cases of influenza on our records. This disease was not made reportable until the epidemic was about three weeks under way. Hence this figure is no indication of the real prevalence of the disease.

The venereal diseases, gonorrhœa and syphilis, were made reportable early in the year. The number reported does not meet our belief as to the actual prevalence of these diseases. We feel, however, that we have made an excellent start in obtaining some definite knowledge of their prevalence and distribution, and hope for more complete results in the future.

The following table gives the number of reported cases of our most prevalent communicable diseases in their 1918 order of incidence, in comparison with the 1917 figures: —

Disease.	1917.	1918.	Increase.	Decrease.
Influenza,	-	145,262	-	-
Measles,	23,880	29,215	5,335	-
Lobar pneumonia,	1,756	13,374	11,618	-
German measles,	5,890	9,426	3,536	-
Tuberculosis, pulmonary,	8,365	7,833	-	532
Whooping cough,	3,877	7,765	3,888	-
Gonorrhœa,	-	7,681	-	-
Diphtheria,	10,322	6,922	-	3,400
Mumps,	7,125	4,972	-	2,153
Scarlet fever,	5,953	4,490	-	1,463
Chicken pox,	7,210	4,117	-	3,093
Syphilis,	-	3,284	-	-
Ophthalmia neonatorum,	2,325	1,877	-	448
Typhoid fever,	1,546	1,067	-	482

Distribution of Biological Products and Diagnostic Outfits.

The following gives the total number of biological products and diagnostic outfits distributed by the State Department of Health during the year ending Nov. 30, 1918: —

Biological Products.

Diphtheria antitoxin: —

12,000 units (for the Boston City Hospital),	3,502 bottles.
12,000 units,	370 bottles.
6,000 units (for the Boston City Hospital),	192 bottles.
6,000 units,	5,054 bottles.
3,000 units,	33,480 bottles.
2,000 units (for the Boston City Hospital),	310 bottles.
2,000 units,	2 bottles.
1,500 units,	2,759 bottles.
1,000 units,	6,931 bottles.
750 units,	1,315 bottles.

Smallpox vaccine: —	
Capillary tubes,	199,079
Bulk,	12,300 cubic centimeters.
Typhoid vaccine: —	
Ampoules,	10,714
Bulk,	14,975 cubic centimeters.
Typhoid-paratyphoid vaccine: —	
Ampoules,	13,114
Bulk,	12,250 cubic centimeters.
Paratyphoid vaccine: —	
Ampoules,	1,715
Bulk,	50 cubic centimeters.
Antimeningitis serum,	4,867 bottles.
Silver nitrate solution,	48,504 ampoules.

Diagnostic Outfits.

Diphtheria culture tubes,	11,563
Tuberculosis sputum bottles,	5,192
Culture media,	130
Pneumonia outfits,	748
Widal outfits,	2,163
Typhoid culture outfits,	565
Malaria-gonorrhœa outfits,	744

Diagnostic Laboratory.

The total number of examinations made from Dec. 1, 1917, to Dec. 1, 1918, was approximately 18,800.

This is 3,000 less than the average for the last few years. The decrease is due to the small number of school cultures examined for diphtheria, compared with other years. Fewer typhoid cultures were examined also.

There were 396 specimens of feces, urine and blood examined for typhoid bacilli, of which 36 were positive; 8 carriers have been located.

Pneumococcus type determinations have been carried on throughout the year. There have been 997 specimens of sputum examined, many of them in duplicate to compare different methods.

The results were as follows: —

Type I,	92
Type II,	111
Type III,	101
Type IV,	379
Streptococci,	78
No pneumococci (mixed growth),	236

The laboratory staff has taught 20 visitors various branches of the work during the year. The time spent by these pupils has varied from two days to eight weeks, the average being four weeks. A six weeks' course of three hours per day was given to eight college graduates to fit them for war service. The colleges represented were Smith, Simmons and Massachusetts Institute of Technology.

Report of the Subdivision of Tuberculosis of the Division of Communicable Diseases for the Year 1918.

During the period from Dec. 1, 1917, to Nov. 30, 1918, there were 7,930 cases of pulmonary tuberculosis reported and 768 cases of non-pulmonary tuberculosis. There were 5,010 deaths from pulmonary tuberculosis and 724 deaths from non-pulmonary tuberculosis. Of the 8,698 cases of tuberculosis reported up to Nov. 30, 1918, about 1,100 of these were positive and suspected cases of tuberculosis called to the attention of the Department during the year by the local exemption boards and cantonments in the country; 615 of these were positive cases that in all probability would not have come to the attention of the Department through any other source.

Follow-up Work.

An effort is being made to secure follow-up work in all cases of tuberculosis, and to keep on file in the office of the State Department of Health accurate data in regard to each patient. Up to the present time 7,550 histories of tuberculosis patients have been received from nurses engaged in either full or part time tuberculosis nursing.

Supervision of Tuberculosis Dispensaries.

The dispensary supervisor has visited the tuberculosis dispensaries in the Northeastern Health District. A detailed report on each dispensary has been sent out to the Health Officer in the district. This supervision should result in more complete and accurate records in the tuberculosis dispensaries. It should also eliminate the cards representing those who have died, or who have left the State, from the active case files in the office of the State Health Department.

Barnstable County Survey.

A tuberculosis survey of Barnstable County was made in April, 1918. This survey established the fact that there was a sufficient number of tuberculosis patients to fill the county hospital.

Cambridge Survey.

A tuberculosis survey of the city of Cambridge was commenced July 1, 1918. Due to the lack of nursing assistance and to the influenza epidemic this survey will not be completed until January, 1919.

Influenza Epidemic.

During the epidemic the entire force of the subdivision was engaged in enrolling, assigning and reassigning nurses and nursing assistants to afflicted cities and towns in the Commonwealth. Approximately 1,100 nurses and nursing assistants were enrolled. There were 1,330 assignments to 106 cities and towns.[1]

Subdivision of Venereal Diseases.

The organization of the work of this subdivision has presented peculiar problems. Ordinarily a new departure in public health work starts in a small way and develops slowly, but here the immense problems of venereal diseases as such, and their physical, mental, moral, spiritual, economic and sociological results and ramifications, were simultaneously thrust for solution upon public officials by awakened public knowledge and public demand for relief. The Department came early to the conclusion that, in its capacity of an official public health organization, it must confine its activities to disease eradication, and must leave the questions of physical, mental and moral results to other agencies. Just where to draw this line in practice is a difficult question to settle. The prevention of a contagious disease usually involves interference with the movements of persons not actively but potentially diseased, and public opinion, while demanding protection from venereal diseases, is still tender and hesitating in its treatment of the morally guilty in order to protect the sensibilities of morally innocent sufferers. It is therefore difficult to discover and render non-infectious many of the most dangerous sources of infection.

The Department has secured the establishment of and is subsidizing with money and with arsphenamine twelve of the sixteen proposed venereal clinics located in centers throughout the State. Here expert treatment and consultation are available. The four remaining clinics will soon be established, as will also a few subclinics. The attendance at these clinics appears to be increasing.

The manufacture of arsphenamine is increasing in volume. The distribution of doses has been as follows: —

[1] The difference between the number enrolled and the number assigned is due to the fact that some nurses, on the completion of their work in one town, were reassigned to another town.

January to July,	650
July,	84
August,	467
September,	445
October,	535
November,	1,057
	3,238

During the year the venereal diseases have been reported by number, as follows: —

Gonorrhœa: —		
Male,	5,149	
Female,	1,868	
Unknown,	19	
		7,036
Syphilis: —		
Male,	1,767	
Female,	1,219	
Unknown,	26	
		3,012
Total,		10,048

Of these, 1,182 were reported by name as cases which were neglecting treatment and should have official supervision in order to protect others from their disease. These were divided as follows: gonorrhœa, 826; syphilis, 356. These cases are the type of negligent or wilful persons who are the most dangerous disseminators of venereal disease. As they are actually diseased they come within our conception of the limits of our duty. Through our epidemiologist, these cases are reported to their local boards and every assistance given in pursuit of them. The record is as follows: —

Unable to locate (because of false address or leaving the State),		265
Gonorrhœa,	208	
Syphilis,	57	
Still in process of follow-up,		338
Gonorrhœa,	247	
Syphilis,	91	
Returned to treatment,		579
Gonorrhœa,	371	
Syphilis,	208	

That almost 50 per cent of the wilful negligent class have been found and brought back to supervised treatment is remarkable.

Inspection of Hospitals.

During the year 82 hospitals were inspected, 43 of these were general and 39 were special. In no instance was any definitely unsanitary condition or practice found.

Inspection of Lock-ups and Houses of Detention.

A total of 196 reformatories, jails, houses of correction, lock-ups and police stations were inspected. In 12 of the lock-ups and police stations conditions were found that warranted action by the District Health Officer. All of the others were in a satisfactory sanitary condition.

Report of the Epidemiologist for the Year ending Nov. 30, 1918.

Actinomycosis. — Actinomycosis was reported but once during the year. This case occurred in the city of Cambridge, and was due, in all probability, to infected beef.

Anterior Poliomyelitis. — During the year 99 cases, with 38 deaths, were reported to this office. The cases occurred sporadically throughout the State, and in no instance showed any evidence of assuming epidemic proportion.

No change occurred in seasonal, age or sex incidence from that recorded in other years.

Total cases,	99
Total deaths,	38
Case rate per 100,000 population,	2.5
Death rate per 100,000 population,	1.0

Anthrax. — The total number of anthrax cases reported for the year was 23, with 7 deaths. These cases were scattered throughout the State, and all but 3 were infected by hides imported into this country from China on consular certification, and therefore without disinfection.

The procedure formulated by the Department in 1915 has been carefully followed, and, with the co-operation of the State Board of Labor and Industries, the brokers from whom the hides were purchased have been notified that certain lots were infected with anthrax. The brokers in turn notified the manufacturers who received the hides and they disinfected them.

Two cases occurred among wool workers, and one in a boy who worked in a hair-renovating factory. As these 3 cases were not verified by laboratory test there is some doubt as to the correctness of diagnosis.

Chicken Pox. — A marked decrease in reported cases was shown this year, the total number of cases being 4,117, with 8 deaths, as compared with 7,210 cases and 20 deaths for 1917.

Public health interest in chicken pox lies in the fact that since every now and again smallpox showing an atypical course and form of eruption closely simulates chicken pox, there is grave danger of confusing the two diseases. With the reporting of chicken pox we are able to note cases occurring in the later age groups; or, if an undue number of deaths occur, no time is lost in starting an investigation to differentiate the conditions and rule out smallpox.

Dog Bite. — Dog bite was officially reported in 20 instances. Upon investigation it was found that 16 dogs and 1 cow gave positive findings.

Residents of the following cities and towns were bitten: Attleboro, 1; Barre, 3; Boston, 3; Charlton, 1; Clinton, 1; Lawrence, 1; Lowell, 1; Methuen, 1; North Attleborough, 3; Taunton (same dog), 2; Ware, 1; Worcester, 2.

In Plainville one person was either bitten or licked by a cow which had received its infection from a rabid dog.

Lancaster and Quincy each reported a dog bite, but upon investigation by the District Health Officer it was found that no one had been infected.

Dysentery. — During the year 79 cases of dysentery were reported and 75 deaths. Many of these cases were diagnosed solely upon clinical findings, and some on investigation proved not to be true dysentery, but rather an enteric disturbance caused by indiscretions of diet, and save in elderly people not of serious import.

One investigation was made in Randolph, where a young child died and 3 other members of the family had been ill. Autopsy showed no great pathological change save minute ulceration in rectum. Bacteriological examination proved the presence of the Shiga bacillus.

In Milton 4 children and their mother became ill with symptoms of a violent dysenteric attack, 2 of the younger children died and the remaining patients recovered after a somewhat protracted illness. The course of the mother's seizure became almost typical of typhoid. Laboratory examinations were negative for all the patients.

Epidemic Cerebrospinal Meningitis. — Epidemic cerebrospinal meningitis was reported in 378 instances, an increase of 182 cases over 1917, when 196 cases were reported; 229 deaths were reported in 1918 as compared with 158 during 1917.

From the case histories received it is apparent that many of the cases were diagnosed just before the death of the patient and on clinical symptoms alone. A study of these histories showed that at least

50 per cent of the cases presented good grounds for doubting the accuracy of the diagnosis.

Public health interest in epidemic cerebrospinal meningitis lies in the fact that the mortality rate is extremely high, and it possesses all the features of a communicable disease. Its mode of transmission is by contact with either the acutely ill or the healthy carrier. Its diagnosis may be made by bacteriological examination for the acutely ill and the carrier. The findings of the *diplococcus intracellularis meningitidis* in the spinal fluid or in the nasopharynx definitely classifies the condition, and the use of the Flexner serum given intradurally is the only curative agent known.

In view of the fact that the serum is harmless, it is most earnestly recommended that it be administered at the time the spinal puncture is made for diagnosis.

German Measles. — German measles was reported in 9,426 instances, with 8 deaths. Because of the frequency with which German measles is confused with the more serious eruptive fevers, such as scarlet fever, the value of reporting it to boards of health is apparent.

Leprosy. — Three cases of leprosy were reported during the year; 2 cases were placed in the Leprosarium at Penikese Island, and one, who knew that a neighboring State did not quarantine for this condition in the earlier stages of the disease, left the State before he could be apprehended.

Lobar Pneumonia. — During the year 13,374 cases of lobar pneumonia were reported. A large number of these cases were reported during the pandemic of influenza, so that it is fair to assume that many "influenza-pneumonias" are included in this number.

As lobar pneumonia has been reportable since May, 1917, only, there has not been a sufficient sequence of reported cases to establish an index which will be of value.

Malaria. — Our malaria problem is by no means reflected by the number of cases reported. More liberal use of the laboratory will surely show a larger number of cases to be reported. With so many breeding places in the State of large numbers of the proper species of mosquito, and an uncertain number of healthy carriers among both our resident and our floating population, this is only to be expected.

Measles. — The warning goes forth yearly that measles is not a simple disease of childhood, to be contracted because "now is a good time to have it." It has been definitely proven that measles, while not serious in itself, does by some unknown process prepare the patient for the invasion of an added infection whose mortality rate is appalling.

The predominant organism in this complication is the *streptococcus hemolyticus* found in many healthy carriers. When these carriers come

in contact with those slightly ill, or recovering from measles, most disastrous consequences are liable to follow.

Other complications, such as pulmonary tuberculosis and otitis media, are relatively frequent in occurrence and dire in their consequences.

Outbreaks.

During the year 1918 there have been but 39 outbreaks of sufficient size to occasion the sending of "outbreak" notices.

Diphtheria seemed to be approaching epidemic proportion in 12 instances, giving a total of 285 cases investigated. The highest total number of cases in any of these outbreaks was 37. Contact was shown to be the main factor in each outbreak.

Measles. — Thirty-three cities showed undue prevalence for measles; 10,624 cases were reported under epidemic conditions. Boston, Quincy, Beverly, Haverhill, Somerville, Marlborough and Springfield reported over 400 cases each during February, March and April.

Scarlet Fever. — In 9 instances scarlet fever appeared in excessive numbers. One outbreak totaled 124 cases and proved to be transmitted by milk. The total number of cases for these outbreaks was 280.

Typhoid Fever. — Only in one instance did typhoid fever reach the proportion of an epidemic. One city, with 33 cases, due to milk infection, showed alarming incidence.

Influenza in Massachusetts.

Influenza, with its 145,262 reported cases and 11,100 deaths, is the outstanding feature of our work for the year 1918.

The explosive nature of the pandemic, our ignorance as to etiology, mode of transmission and excessive death rate, together with the anxiety of the citizens of the State, made the problem extremely difficult to handle.

Early in the beginning of the outbreak it seemed that our only hope to prevent the spread of the infection was to prevent contact infection, and this we tried to do. Our results were negative; we did not, and, in fact, could not, stem the tide of this overwhelming invasion when the foci of infection were scattered over the State with no means available to detect their presence unless, perchance, they were acutely ill.

Much time, money and energy were spent developing a vaccine which might have prophylactic value, and which would lessen the incidence of the infection. No statistics have been produced which prove that this vaccine had any value.

The one phase of our work which furnished satisfaction to us was that we were able to furnish a sufficient number of physicians and

nurses to help in the care of those afflicted. During this period 238 physicians and 1,097 nurses were sent out from this office to the stricken communities.

Epidemiology. — The pandemic of influenza appeared in Massachusetts during the latter part of August, the first known cases being diagnosed at the Naval Hospital in Chelsea, as noted in the United States Public Health Service Report.

As influenza was not made reportable by the State Department of Health until October 4, its onset must be estimated by the death returns, or from the reports furnished voluntarily by the physicians. From these data the onset and progress of the disease in this State was in part as follows: —

	Onset.	
	By Deaths.	By Reports.
Chelsea (Naval Hospital),	-	Aug. 10
Haverhill,	Sept. 12	Sept. 8
Boston,	Sept. 7	Sept. 13
Medford,	Sept. 10	Sept. 13
Winthrop,	Sept. 11	Sept. 13
Chelsea (civilian),	Aug. 28	Sept. 16
New Bedford,	Sept. 8	Sept. 19
Pittsfield,	Sept. 13	Sept. 19
Lowell,	Sept. 14	Sept. 20
Arlington,	Sept. 10	Sept. 21
Springfield,	Sept. 23	Sept. 23
Greenfield,	Sept. 22	Sept. 26
North Adams,	Sept. 23	Sept. 30

Thus it appears that the first cases in the State were discovered in the eastern section, and, following the usual lines of travel, reached the western cities and towns in approximately two weeks.

An interesting feature in the onset of influenza in this State was the sudden increase in number of reported cases of lobar pneumonia from Camp Devens. During the month of August, up to the 26th, there were reported but 12 cases, while from the 26th to September 1, 98 cases were reported, making a total for the month of 110 cases. This sudden increase of lobar pneumonia may possibly have been due to an unrecognized infection of influenzal origin.

Etiology. — The etiology of influenza is as yet undetermined. While a majority of observers have agreed that the pneumococci, the streptococci, both hemolytic and viridans strains, *micrococcus catarrhalis* and influenza bacillus are present in the complications, none are agreed on the initial invading organism. Some feel that a diplostreptococcus is the offending agent, while others lean toward the theory of a filterable virus; and so it goes on, with no definite proof of the actual agent yet available.

It is of interest to note that all experimental efforts to infect volunteers have failed thus far.

The incidence of the infection varied widely and for no apparent reason. For instance, Marlborough, surrounded by cities and towns almost overwhelmed by the outbreak, had few cases and needed no help. The case rate must remain unknown. The disease was not reportable at the time of the beginning of the outbreak, and the volume of cases made estimates particularly unreliable. Through information from all available sources the number in Boston alone is put at 200,000, and for the whole State at 500,000.

At Camp Devens from October 2 to October 29 there were 231 cases of influenza-pneumonia, and of this number 127 died, a fatality of 54.9 per cent. Of the 2,817 cases at this camp, reported from September 4 to October 29, 787 died, or 27.9 per cent. The Naval Hospital in Chelsea had about the same percentages, save in 150 cases treated with the serum from convalescent influenza-pneumonia cases, where the fatality was only 4 per cent.

The mortality rate for the State varied widely. Gloucester, with a rate of 9 per 100,000 population, was apparently the most severely afflicted city in the State. The general rate for the State was given by the United States Public Health Service as 5.4.

One striking feature was the marked decrease in the fatality rate as the pandemic progressed. Early in the outbreak the reported mortality of influenza-pneumonia from hospitals was nearly 60 per cent.

Modes of Transmission. — As the etiology of influenza is not yet determined, the mode or modes of transmission cannot be positively stated; but since the disease attacks principally the respiratory tract, it seems very probable that the infective micro-organism or virus is contained in the secretions and discharges of this tract, and that the infection is spread mainly through these discharges. If this be so, then droplet infection must be considered as one of the principal modes of transmission of the disease. Likewise contact, both direct and indirect, will prove to be another important means of spread.

Prevention and Control. — The methods of prevention and control of

influenza, and the efficiency of the measures generally adopted during the epidemic; the general closing orders; the use of masks; the care of hands; the care of food and utensils; the use of prophylactic vaccines; and the isolation and quarantine of patients have been widely discussed.

From the lack of knowledge of the etiology, the lack of knowledge of prophylactic vaccines, the lack of knowledge of the exact modes of transmission, no definite measures of control could be formulated that would be applicable to all communities, but it did seem to be the general opinion that the following measures were best adapted to aid in the control of influenza: —

1. Compulsory reporting of cases of patients ill with influenza.
2. Isolation of patient and quarantine if necessary.
3. Disinfection of discharges from the nose and throat.
4. Wearing of masks by attendants in sick room.
5. Care of the hands of patients.
6. Care of food utensils.
7. General closing orders, especially those places where crowding was most liable to occur.
8. Education and publicity.

Cases and Deaths, with Case and Death Rates, per 100,000 Population for All Reportable Diseases during the Year 1918.

Disease.	Cases.	Deaths.	Case Rate.	Death Rate.
Actinomycosis,	1	-	.03	-
Anterior poliomyelitis,	99	38	2.5	1.0
Anthrax,	23	7	.6	.2
Chicken pox,	4,117	8	105.0	.2
Diphtheria,	6,922	604	176.5	15.4
Dog bite,	20	-	.5	-
Dysentery,	79	75	2.0	1.9
Epidemic cerebrospinal meningitis,	378	229	9.6	5.8
German measles,	9,426	8	240.4	.2
Gonorrhœa,[1]	7,681	8	195.9	.2
Influenza,[2]	145,262	11,100	3,704.7	283.1
Leprosy,	3	-	.1	-
Malaria,	82	4	2.1	.1
Measles,	29,215	533	745.1	13.5
Mumps,	4,972	9	126.8	.2
Ophthalmia,	1,877	1	47.9	.03
Pellagra,	19	22	.5	.6

[1] Made reportable Feb. 1, 1918. [2] Made reportable Oct. 4, 1918.

Cases and Deaths, with Case and Death Rates, per 100,000 Population for All Reportable Diseases during the Year 1918 — Concluded.

Disease.	Cases.	Deaths.	Case Rate.	Death Rate.
Pneumonia, lobar,	13,374	9,787	341.1	249.6
Scarlet fever,	4,490	77	114.5	2.0
Septic sore throat,	107	25	2.7	.6
Syphilis,[1]	3,284	261	83.8	6.7
Smallpox,	27	-	.7	-
Tetanus,	27	32	.7	.8
Trachoma,	103	-	2.6	-
Trichinosis,	15	-	.4	-
Tuberculosis, pulmonary,	7,833	5,106	200.0	130.2
Tuberculosis, other forms,	747	786	19.1	20.0
Typhoid fever,	1,067	160	27.2	4.1
Typhus fever,	2	1	.05	.03
Whooping cough,	7,765	719	198.0	18.3

[1] Made reportable Feb. 1, 1918.

Incidence of Communicable Diseases by Months, 1918.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
Actinomycosis,	1	-	-	-	-	-	-	-	-	-	-	-	1
Anterior poliomyelitis,	5	3	6	6	6	6	10	20	20	7	7	3	99
Anthrax,	1	5	2	1	-	3	4	1	3	-	3	-	23
Chicken pox,	872	490	422	434	609	356	312	88	63	74	141	256	4,117
Diphtheria,	950	678	744	667	663	473	453	337	430	410	532	585	6,922
Dog bite,	2	-	-	1	6	2	1	2	2	2	4	1	23
Dysentery,	-	2	2	-	-	4	30	20	11	3	6	1	79
Epidemic cerebrospinal meningitis,	21	35	51	67	36	36	25	18	18	31	19	21	378
German measles,	705	1,415	2,149	2,411	2,070	490	97	32	14	15	8	20	9,426
Ophthalmia neonatorum,	134	133	133	155	114	113	131	120	92	80	71	90	1,366
Suppurative conjunctivitis,	39	46	69	106	62	30	33	23	25	21	31	26	511
Leprosy,	-	-	-	-	-	2	-	-	-	1	-	-	3
Malaria,	-	1	2	5	4	5	16	31	9	4	2	3	82
Measles,	2,950	3,471	4,018	5,210	6,335	3,663	1,962	500	263	318	179	346	29,215
Mumps,	711	678	722	794	743	472	190	71	80	174	203	134	4,972
Pellagra,	-	-	2	2	2	6	1	2	1	2	1	-	19
Pneumonia (lobar),	698	876	800	1,184	573	204	139	171	3,114	3,797	615	1,203	13,374
Scarlet fever,	609	537	540	626	487	287	200	122	177	225	287	393	4,490
Septic sore throat,	16	12	13	19	10	12	3	2	2	4	4	10	107
Smallpox,	3	2	10	2	3	1	1	-	2	-	3	-	27
Tetanus,	1	-	2	-	3	3	4	2	4	4	2	2	27
Trachoma,	9	7	8	10	9	11	8	17	6	4	5	9	103
Trichinosis,	9	5	-	-	-	-	1	-	-	-	-	-	15
Tuberculosis, pulmonary,	637	676	815	779	884	764	613	604	570	439	525	527	7,833
Tuberculosis, other forms,	69	76	84	86	80	54	82	58	48	24	45	41	747
Typhoid fever,	54	38	41	53	71	64	112	184	261	97	49	44	1,067
Typhus fever,	-	1	-	-	1	-	-	-	-	-	-	-	2
Whooping cough,	865	679	759	855	1,001	829	781	688	543	332	216	217	7,765
Gonorrhœa,[1]	-	47	982	835	787	815	750	828	669	552	771	645	7,681
Syphilis,[1]	-	16	376	415	334	329	285	360	298	233	365	273	3,284
Influenza,[2]	-	-	-	-	-	-	-	-	-	88,494	14,750	42,018	145,262
	9,361	9,929	12,752	14,722	14,893	9,034	6,244	4,301	6,725	95,347	18,844	46,868	249,020

[1] Not reportable until February, 1918.

[2] Made reportable Oct. 4, 1918.

Index to Line Numbers in the Table of Cases and Deaths from Diseases Dangerous to the Public Health, 1918.

Index to Line Numbers in the Table of Cases and Deaths from Diseases Dangerous to the Public Health, 1918 — Continued.

Index to Line Numbers in the Table of Cases and Deaths from Diseases Dangerous to the Public Health, 1918 — Concluded.

Cases and Deaths from Diseases Dangerous

Line No.	Cities and Towns grouped in Order of Population.	Population estimated as of July 1, 1918.	19A Chicken Pox.		61A Ep. Cerebro-spinal Meningitis.		9 Diphtheria.		19B German Measles.		92 Lobar Pneumonia.		6 Measles.	
			Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
1	Massachusetts,	3,920,963	4117	6	378	229	6022	694	9426	3	13374	9787	29215	[illegible]
2	Cities over 500,000.													
3	Boston,	766,471	750	-	111	77	2443	[illegible]	722	-	2256	[illegible]	6261	107
4	Cities over 150,000.													
5	Worcester,	173,419	73	1	28	16	215	21	240	-	957	684	815	8
6	Cities, 100,000-150,000.	*578,598*	*566*	*1*	*59*	*31*	*1101*	*108*	*480*	*1*	[illegible]	*1475*	*3473*	*94*
7	Fall River,	128,317	87	-	12	7	166	27	60	-	396	369	218	9
8	New Bedford,	117,855	84	1	4	[illegible]	110	20	11	-	240	271	[illegible]	36
9	Springfield,	111,983	169	-	6	6	[illegible]	21	179	-	853	306	968	12
10	Cambridge,	111,379	213	-	19	8	401	12	219	1	[illegible]	291	1412	35
11	Lowell,	109,050	35	-	13	9	193	18	71	-	127	307	404	13
12	Cities, 50,000-100,000.	*569,719*	*575*	*3*	*49*	*36*	*940*	*90*	*1146*	*1*	*1913*	*1308*	*4872*	*115*
13	Lynn,	99,952	28	-	6	2	146	8	360	1	261	172	307	6
14	Lawrence,	98,060	33	-	10	9	107	18	22	-	194	199	[illegible]	76
15	Somerville,	93,026	81	1	5	3	254	23	124	-	216	126	852	10
16	Brockton,	65,746	77	-	2	1	[illegible]	2	379	-	179	121	222	1
17	Holyoke,	62,796	37	1	1	2	47	6	6	-	131	186	189	2
18	Haverhill,	52,873	88	1	3	3	88	9	141	-	641	260	717	7
19	Malden,	51,798	81	-	9	5	166	20	59	-	[illegible]	119	584	1
20	Chelsea,	50,458	50	-	18	11	82	4	25	-	222	145	504	12
21	Cities and Towns, 25,000-50,000.	*487,764*	*696*	-	[illegible]	*19*	*759*	*57*	*1970*	*1*	*1104*	*1060*	*4696*	*63*
22	Quincy,	[illegible]27	90	-	3	-	84	6	181	-	64	98	794	11
23	Newton,	[illegible]34	196	-	3	1	104	12	505	-	[illegible]	67	393	4
24	Pittsfield,	[illegible]10	39	-	10	5	28	2	145	-	142	128	94	1
25	Salem,	[illegible]62	33	-	7	3	47	3	107	-	182	105	527	9
26	Fitchburg,	[illegible]80	28	-	3	5	67	6	172	-	[illegible]	147	464	18
27	Everett,	[illegible]35	18	-	-	1	112	2	[illegible]	-	[illegible]	108	[illegible]	-
28	Taunton,	[illegible]81	12	-	1	1	20	1	1	-	28	114	86	1
29	Brookline,	[illegible]47	137	-	1	-	42	2	392	-	133	64	506	-
30	Medford,	[illegible]80	35	-	4	-	69	6	70	-	[illegible]	54	256	-
31	Chicopee,	[illegible]77	23	-	2	2	56	11	2	-	26	39	89	1
32	Waltham,	[illegible]43	87	-	2	3	[illegible]	2	104	1	27	62	676	6
33	Revere,	[illegible]43	-	-	4	-	77	[illegible]	-	-	30	46	-	3
34	Beverly,	[illegible]25	9	-	1	-	15	-	66	-	50	27	551	7
35	Cities and Towns, 10,000-25,000.	*575,996*	*812*	*1*	*33*	*25*	*774*	*53*	*3056*	[illegible]	*1410*	*1315*	*4111*	*67*
36	Gloucester,	24,570	[illegible]	-	1	1	14	1	26	-	23	92	45	5
37	Northampton,	23,081	40	-	-	-	20	6	62	-	44	26	100	-
38	North Adams,	22,045	19	-	1	1	11	3	7	-	33	35	6	-
39	Peabody,	20,489	16	-	-	2	30	6	25	-	34	35	223	3
40	Attleboro,	19,933	17	1	-	-	13	1	133	-	63	60	54	1
41	Westfield,	19,929	63	-	2	-	31	7	119	-	153	66	26	1
42	Watertown,	18,851	9	-	2	-	35	1	21	1	50	61	153	2
43	Framingham,	17,726	30	-	-	1	12	-	344	-	28	26	61	1

to the Public Health, 1918.

19C Mumps.		38A[1] Ophthalmia Neonatorum.		7 Scarlet Fever.		28-29 Tuberculosis, Pulmonary.		30-35 Tuberculosis, Other Forms.		1 Typhoid Fever.		8 Whooping Cough.		100 Septic Sore Throat.		75A Trachoma.		38C Gonorrhœa.		37 Syphilis.		
Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Line No.
4972	9	1877	1	4490	77	7833	5106	747	786	1067	160	7765	719	107	25	103	-	7681	8	3284	261	1
																						2
783	1	623	-	974	26	2649	1161	252	191	99	22	2002	179	21	3	61	-	3399	-	1494	60	3
																						4
16	1	149	1	179	2	318	203	24	47	23	6	55	6	-	1	4	-	359	-	178	23	5
654	*1*	*410*	-	*472*	*10*	*1387*	*954*	*152*	*162*	*283*	*39*	*1399*	*153*	*16*	*3*	*13*	-	*976*	-	*317*	*24*	6
114	-	116	-	114	-	354	226	32	24	158	18	310	33	11	1	1	-	205	-	65	7	7
24	-	123	-	57	3	414	221	48	46	50	11	141	29	-	-	1	-	188	-	35	5	8
398	-	72	-	141	3	185	127	31	28	32	4	302	37	1	1	2	-	279	-	88	5	9
114	1	50	-	63	-	212	223	27	24	23	4	588	32	2	-	6	-	177	-	75	1	10
4	-	49	-	97	4	222	157	14	40	20	2	58	22	2	1	3	-	127	-	54	6	11
328	*2*	*363*	-	*631*	*10*	*981*	*568*	*113*	*87*	*147*	*26*	*1085*	*107*	*9*	*3*	*11*	-	*654*	-	*229*	*25*	12
45	-	73	-	109	2	158	107	17	17	22	2	199	23	1	1	-	-	127	-	53	9	13
11	-	12	-	16	-	208	143	41	29	36	10	189	23	-	-	2	-	62	-	53	4	14
27	-	29	-	102	-	145	74	8	7	14	2	122	16	1	1	2	-	68	-	31	1	15
154	-	96	-	158	1	101	53	11	6	22	6	273	6	-	-	-	-	92	-	32	2	16
16	-	9	-	61	1	77	68	3	3	8	1	42	17	-	-	-	-	57	-	4	3	17
54	1	49	-	57	2	120	39	14	5	17	3	63	6	6	1	1	-	142	-	31	2	18
6	1	27	-	68	3	68	37	11	10	14	1	93	7	-	-	-	-	35	-	12	2	19
15	-	68	-	60	1	104	47	8	5	14	1	104	9	1	-	6	-	71	-	13	2	20
409	*2*	*98*	-	*608*	*8*	*871*	*502*	*73*	*83*	*119*	*22*	*1023*	*78*	*18*	*4*	*2*	-	*470*	*1*	*136*	*39*	21
19	-	6	-	61	-	72	34	5	9	6	2	75	6	-	-	-	-	44	-	10	2	22
89	1	10	-	29	1	55	28	9	13	9	2	312	3	4	3	-	-	25	-	10	3	23
24	-	13	-	104	2	109	53	10	9	5	-	36	2	-	-	-	-	49	-	17	1	24
42	-	11	-	58	1	58	50	9	6	7	3	9	2	3	1	-	-	50	1	10	2	25
52	1	6	-	37	1	105	45	14	5	6	1	73	10	-	-	1	-	56	-	10	3	26
15	-	18	-	52	-	85	34	6	4	11	1	88	4	1	-	-	-	30	-	6	-	27
27	-	3	-	46	2	134	94	5	6	11	-	84	15	-	-	-	-	28	-	17	24	28
49	-	-	-	66	-	44	33	4	-	4	-	178	2	4	-	-	-	8	-	5	-	29
3	-	5	-	62	-	37	27	2	5	5	-	33	10	2	-	1	-	22	-	6	-	30
24	-	7	-	7	-	71	51	1	11	3	-	13	2	1	-	-	-	12	-	3	-	31
60	-	10	-	24	1	36	32	7	13	2	2	101	13	1	-	-	-	46	-	10	2	32
-	-	3	-	44	-	39	11	-	-	12	4	-	5	-	-	-	-	82	-	27	1	33
5	-	6	-	18	-	26	10	1	2	38	7	21	4	2	-	-	-	18	-	5	1	34
1017	-	*118*	-	*651*	*5*	*815*	*572*	*68*	*96*	*187*	*22*	*999*	*97*	*16*	*8*	*10*	-	*385*	*7*	*167*	*37*	35
2	-	2	-	47	-	50	19	8	4	18	1	9	1	1	1	4	-	21	-	9	2	36
34	-	4	-	32	1	39	68	3	6	3	3	23	2	-	-	1	-	9	4	17	23	37
9	-	2	-	3	-	31	23	3	3	6	2	22	1	-	-	-	-	5	1	1	-	38
17	-	5	-	16	-	37	13	6	4	5	-	3	4	-	-	1	-	25	-	3	-	39
5	-	3	-	8	-	17	10	5	6	3	1	59	3	1	-	-	-	15	-	15	1	40
93	-	4	-	69	1	29	62	3	-	11	-	43	2	-	-	-	-	7	-	3	-	41
4	-	3	-	25	-	29	12	1	2	3	-	54	1	3	1	1	-	12	-	9	-	42
11	-	3	-	12	-	38	9	1	-	4	-	67	2	1	-	-	-	17	-	4	-	43

[1] Including 511 cases of suppurative conjuctivitis.

Cases and Deaths from Diseases Dangerous

Line No.	Cities and Towns grouped in Order of Population.	Population estimated as of July 1, 1918.	10A Chicken Pox.		61A Ep. Cerebrospinal Meningitis.		9 Diphtheria.		10B German Measles.		92 Lobar Pneumonia.		6 Measles.	
			Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
44	Leominster,	[illegible]88	24	–	2	–	28	3	87	–	97	87	194	–
45	Melrose,	[illegible]27	46	–	–	–	24	2	108	–	76	64	[illegible]	–
46	Gardner,	51	[illegible]	–	–	–	100	1	114	–	55	70	51	1
47	Arlington,	64	21	–	1	–	33	1	49	–	17	41	140	–
48	Woburn,	16	7	–	–	1	16	–	29	–	16	18	101	2
49	Marlborough,	60	15	–	2	2	15	1	60	–	19	27	794	4
50	Methuen,	49	12	–	–	2	5	–	9	–	9	21	195	7
51	Newburyport,	42	92	–	3	2	5	1	23	–	31	44	63	–
52	Southbridge,	55	4	–	–	–	11	1	–	–	7	56	67	4
53	Weymouth,	60	–	–	1	–	23	1	–	–	18	41	–	1
54	Winthrop,	42	61	–	3	1	31	–	73	–	121	41	105	1
55	Milford,	68	–	–	1	1	6	1	21	–	48	42	155	3
56	Greenfield,	28	87	–	3	3	11	1	146	–	19	41	32	1
57	Wakefield,	64	4	–	1	1	62	3	30	–	5	15	38	–
58	Plymouth,	30	17	–	–	1	39	4	37	1	8	39	32	–
59	Adams,	40	3	–	–	–	5	–	–	–	17	10	8	1
60	Clinton,	96	6	–	1	–	3	–	30	–	60	30	134	1
61	Webster,	42	–	–	–	–	21	[illegible]	11	–	28	56	[illegible]	3
62	Norwood,	79	39	–	1	1	5	–	70	–	15	21	219	6
63	West Springfield,	86	8	–	1	1	16	1	4	–	27	33	13	1
64	Danvers,	[illegible]	[illegible]	–	1	2	12	–	187	–	90	47	32	–
65	Dedham,	72	21	–	–	–	34	3	5	–	6	12	37	–
66	Natick,	24	9	–	1	1	13	1	4	–	68	30	325	3
67	Saugus,	25	1	–	–	–	5	–	–	–	–	11	10	1
68	Easthampton,	82	2	–	1	1	22	1	1	–	16	14	68	3
69	Athol,	82	5	–	–	–	7	1	27	1	11	19	9	–
70	Bridgewater,	48	5	–	2	2	10	2	47	–	21	29	2	–
71	Winchester,	51	62	–	2	–	2	–	86	–	24	9	221	9
72	Braintree,	62	14	–	1	–	20	–	31	–	7	24	251	1
73	Palmer,	19	–	–	–	–	24	2	1	–	2	14	12	–
74	Towns, 5,000–10,000.	*346,607*	*810*	*1*	*24*	*18*	*335*	*56*	*1558*	*1*	*589*	*784*	*3390*	*26*
75	Belmont,	11	10	–	1	–	11	–	90	–	17	16	121	–
76	Ware,	94	–	–	–	1	5	1	[illegible]	–	7	13	12	–
77	Northbridge,	40	–	–	2	1	9	2	15	1	10	21	33	2
78	North Attleborough,	08	4	–	–	–	32	–	–	–	25	20	13	–
79	Milton,	03	31	–	1	–	16	–	67	–	19	9	67	[illegible]
80	Middleborough,	98	24	–	–	–	–	1	44	–	34	12	24	2
81	Montague,	06	4	–	1	2	6	2	5	–	16	45	76	5
82	Andover,	12	12	–	3	–	7	–	196	–	13	10	112	1
83	Swampscott,	77	6	–	1	–	6	–	79	–	6	13	112	3
84	Marblehead,	79	7	–	–	–	2	–	61	–	8	7	7	–
85	Stoneham,	45	1	–	–	–	7	1	4	–	11	11	[illegible]	–
86	Amesbury,	77	1	–	–	–	25	2	21	–	32	36	1	–
87	Whitman,	67	15	–	–	–	–	–	20	–	17	28	6	–
88	Needham,	44	13	–	–	–	4	–	7	–	12	30	78	–
89	Reading,	38	8	1	–	–	5	1	6	–	3	8	5	–
90	Stoughton,	09	–	–	–	–	4	–	2	–	–	17	61	[illegible]
91	Rockland,	67	8	–	–	–	15	6	33	–	20	[illegible]	15	–
92	Wellesley,	97	15	–	1	–	24	–	225	–	27	6	227	1
93	Ludlow,	68	1	–	1	1	6	1	3	–	16	10	73	1
94	Great Barrington,	76	–	–	2	–	8	–	1	–	17	18	43	–
95	Fairhaven,	18	2	–	–	–	2	1	2	–	11	12	9	–
96	Maynard,	14	–	–	–	1	4	1	13	–	–	13	4	–
97	Franklin,	53	9	–	–	1	–	–	33	–	11	9	27	–
98	Concord,	48	15	–	2	–	6	–	18	–	–	36	26	–
99	Hudson,	68	–	–	1	–	4	–	–	–	–	33	51	1
100	Ipswich,	90	1	–	–	–	4	–	7	–	3	6	17	–
101	Grafton,	79	–	–	–	–	10	3	2	–	3	25	1	–
102	Tewksbury,	37	–	–	–	–	1	–	–	–	–	1	–	–
103	Westborough,	33	–	–	–	–	7	–	20	–	29	17	144	–

to the Public Health, 1918 — Continued.

19C Mumps.		38A Ophthalmia Neonatorum.		7 Scarlet Fever.		28-29 Tuberculosis, Pulmonary.		30-35 Tuberculosis, Other Forms.		1 Typhoid Fever.		8 Whooping Cough.		100 Septic Sore Throat.		75A Trachoma.		38C Gonorrhœa.		37 Syphilis.		
Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Line No.
-	-	1	-	15	-	54	24	5	3	3	1	63	7	2	2	-	-	30	-	2	-	44
3	-	24	-	22	-	24	8	-	3	4	1	11	3	3	-	-	-	11	-	-	-	45
4	-	4	-	27	1	41	15	5	5	3	-	103	9	-	-	-	-	8	-	6	-	46
4	-	1	-	11	-	52	21	2	6	4	-	9	1	-	-	-	-	8	-	6	-	47
1	-	1	-	48	-	19	19	-	3	11	-	16	5	-	-	-	-	14	-	2	-	48
9	-	1	-	16	-	23	12	1	5	33	5	7	-	-	-	-	-	6	1	3	1	49
2	-	5	-	8	-	22	12	1	4	9	2	45	3	-	-	-	-	5	-	1	-	50
245	-	8	-	3	-	17	16	4	6	3	-	63	-	3	2	1	-	8	-	3	-	51
1	-	1	-	1	-	26	15	1	1	11	2	-	-	-	-	-	-	12	-	2	-	52
-	-	2	-	8	-	10	5	-	2	3	-	-	1	-	-	-	-	4	-	3	-	53
21	-	4	-	41	-	14	3	-	-	1	-	34	1	1	-	-	-	9	-	1	1	54
-	-	-	-	16	-	20	15	-	3	-	-	30	4	-	-	-	-	5	-	-	-	55
307	-	8	-	36	-	11	4	1	2	1	-	83	7	-	-	-	-	13	-	4	-	56
8	-	-	-	22	-	19	18	1	3	2	-	8	2	-	-	-	-	4	-	3	-	57
1	-	2	-	3	-	18	9	-	4	6	-	18	4	-	-	1	-	7	-	2	1	58
2	-	2	-	17	-	14	12	2	1	4	1	24	3	-	-	-	-	4	-	-	-	59
10	-	-	-	13	-	22	22	1	1	4	1	11	1	-	-	-	-	4	-	3	-	60
1	-	10	-	-	-	24	15	-	1	3	2	32	4	-	-	-	-	17	-	2	-	61
4	-	1	-	11	-	17	10	1	2	3	-	20	-	-	-	-	-	8	-	-	-	62
5	-	3	-	12	-	10	8	-	-	-	-	3	2	-	-	-	-	4	-	-	1	63
111	-	2	-	8	-	9	25	-	2	1	-	1	-	-	-	1	-	7	-	37	3	64
37	-	-	-	11	-	14	8	2	1	1	-	11	2	-	-	-	-	6	-	-	-	65
12	-	2	-	19	-	11	3	1	-	3	-	22	-	-	1	-	-	16	-	14	-	66
1	-	1	-	5	-	8	7	2	-	3	-	4	4	-	-	-	-	3	1	1	2	67
18	-	-	-	5	-	10	6	1	1	-	-	22	2	-	-	-	-	6	-	-	-	68
7	-	1	-	7	-	7	6	2	2	10	-	14	2	-	-	-	-	21	-	2	-	69
4	-	3	-	14	-	3	17	2	6	6	-	28	1	-	-	-	-	5	-	5	1	70
4	-	2	-	4	-	6	3	1	1	1	-	19	1	-	-	-	-	6	-	2	1	71
12	-	2	-	24	1	11	8	1	1	-	-	18	3	-	-	-	-	19	-	2	-	72
8	-	1	-	12	1	9	10	1	2	1	-	-	4	1	1	-	-	4	-	-	-	73
376	*1*	*90*	-	*384*	*5*	*375*	*307*	*33*	*56*	*79*	*9*	*725*	*52*	*9*	*1*	*2*	-	*201*	-	*52*	*10*	74
3	-	1	-	7	-	11	7	2	2	2	-	14	2	-	-	1	-	1	-	2	-	75
-	-	-	-	2	-	9	10	-	2	-	-	-	-	-	-	-	-	6	-	-	-	76
-	-	-	-	17	-	7	10	-	1	1	-	-	2	-	-	-	-	8	-	3	-	77
-	-	-	-	11	-	14	7	-	2	1	1	11	2	-	-	-	-	1	-	1	-	78
75	1	1	-	15	-	11	6	-	1	4	-	64	1	-	-	-	-	10	-	-	-	79
1	-	-	-	6	-	9	1	-	-	-	-	58	1	1	1	-	-	6	-	-	-	80
3	-	1	-	54	3	7	8	-	-	1	-	8	1	-	-	-	-	2	-	-	-	81
27	-	1	-	9	-	6	6	-	-	3	-	2	-	-	-	-	-	4	-	-	-	82
6	-	8	-	7	-	3	4	-	-	1	1	10	-	-	-	-	-	5	-	1	-	83
1	-	-	-	4	-	3	4	1	2	1	-	1	9	-	-	-	-	8	-	1	-	84
4	-	1	-	9	-	7	7	1	1	4	-	2	1	-	-	-	-	5	-	2	1	85
-	-	2	-	5	-	7	11	-	1	2	-	1	2	-	-	-	-	9	-	1	-	86
3	-	1	-	19	-	4	7	1	4	1	-	131	-	-	-	-	-	6	-	1	-	87
2	-	1	-	12	-	7	3	1	2	1	-	3	-	-	-	-	-	1	-	2	-	88
-	-	-	-	6	-	12	5	-	2	5	-	-	-	-	-	-	-	2	-	-	-	89
-	-	2	-	5	-	1	4	1	2	-	-	-	2	-	-	-	-	3	-	-	-	90
-	-	-	-	1	-	12	6	-	1	-	-	14	-	-	-	-	-	5	-	3	2	91
26	-	13	-	4	-	4	3	3	-	1	-	39	-	-	-	-	-	5	-	3	-	92
9	-	5	-	12	-	11	11	1	1	1	-	3	1	-	-	-	-	3	-	-	-	93
5	-	-	-	17	-	4	3	2	4	-	-	13	-	-	-	-	-	5	-	3	-	94
1	-	3	-	5	-	18	7	3	3	1	-	4	4	-	-	-	-	-	-	1	-	95
-	-	-	-	1	1	12	4	1	-	-	-	-	2	-	-	-	-	-	-	-	-	96
-	-	2	-	33	1	8	3	-	-	1	-	14	1	-	-	-	-	11	-	1	-	97
8	-	-	-	8	-	6	1	-	1	2	1	3	-	-	-	1	-	-	-	2	-	98
-	-	4	-	1	-	10	2	-	-	1	-	4	-	1	-	-	-	2	-	1	1	99
-	-	-	-	10	-	7	2	-	-	3	1	9	1	-	-	-	-	3	-	-	2	100
-	-	-	-	7	-	26	32	-	3	1	-	3	2	-	-	-	-	3	-	-	2	101
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	102
-	-	-	-	-	-	23	21	1	1	-	-	-	-	-	-	-	-	5	-	1	1	103

Cases and Deaths from Diseases Dangerous

Line No.	Cities and Towns grouped in Order of Population.	Population estimated as of July 1, 1918.	19A Chicken Pox. Cases.	19A Chicken Pox. Deaths.	61A Ep. Cerebro-spinal Meningitis. Cases.	61A Ep. Cerebro-spinal Meningitis. Deaths.	9 Diphtheria. Cases.	9 Diphtheria. Deaths.	19B German Measles. Cases.	19B German Measles. Deaths.	92 Lobar Pneumonia. Cases.	92 Lobar Pneumonia. Deaths.	6 Measles. Cases.	6 Measles. Deaths.
104	North Andover,	39	2	–	1	2	2	–	5	–	3	6	13	1
105	Canton,	53	9	–	–	–	12	1	49	–	–	14	32	–
106	Mansfield,	60	[illegible]	–	2	–	16	–	102	–	4	6	84	2
107	Winchendon,	66	10	–	2	–	1	–	17	–	10	7	26	–
108	Dartmouth,	40	6	–	–	–	3	–	–	–	9	17	134	2
109	Lexington,	86	15	–	–	–	7	–	28	–	18	14	34	–
110	Walpole,	75	18	–	–	–	2	–	37	–	7	6	94	–
111	Wareham,	86	3	–	–	–	9	1	–	–	12	9	–	–
112	Amherst,	44	5	–	–	–	3	–	56	–	22	7	20	–
113	Abington,	63	4	–	–	–	19	–	50	–	2	9	22	–
114	Millbury,	61	–	–	–	–	1	–	–	–	–	5	–	–
115	Spencer,	16	–	–	1	1	–	–	–	–	1	17	[illegible]	2
116	Hingham,	56	21	–	–	–	7	2	38	–	28	19	135	–
117	Orange,	48	–	–	–	–	7	1	–	–	3	21	1	–
118	South Hadley,	32	1	–	1	1	2	–	11	–	11	8	27	–
119	Chelmsford,	32	–	–	1	1	2	–	25	–	20	9	109	–
120	Agawam,	22	–	–	–	–	4	–	1	–	9	15	3	1
121	Barnstable,	00	6	–	–	–	1	–	42	–	16	9	43	–
122	Monson,	61	9	–	–	–	1	–	5	–	43	40	18	–
123	Uxbridge,	61	–	–	–	–	–	–	1	–	–	12	1	–
124	Easton,	16	–	–	–	–	4	–	–	–	–	6	–	–
125	Randolph,	18	–	–	–	–	1	–	–	–	–	6	–	–
126	*Towns, 2,500–5,000.*	*189,689*	*174*	–	*4*	*9*	*156*	*16*	*680*	*1*	*380*	*388*	*886*	*14*
127	Lee,	4,706	1	–	–	1	–	–	5	–	58	3	1	–
128	Rockport,	4,446	2	–	–	–	–	–	14	–	7	10	47	1
129	Dudley,	41	2	–	–	–	3	–	1	–	9	8	6	2
130	Falmouth,	14	–	–	–	–	9	–	1	–	–	3	9	–
131	Dracut,	32	1	–	–	–	3	–	–	–	1	8	43	–
132	Warren,	19	–	–	–	–	1	2	–	–	16	12	–	–
133	Templeton,	90	2	–	–	–	39	6	11	–	6	6	35	–
134	Provincetown,	47	1	–	–	–	–	–	29	1	2	5	–	–
135	Williamstown,	67	4	–	–	–	1	1	5	–	–	6	1	–
136	Dalton,	44	–	–	–	–	1	–	4	–	1	–	1	–
[illegible]	East Bridgewater,	98	–	–	–	–	1	–	–	–	40	7	–	–
[illegible]	Auburn,	33	4	–	–	–	3	1	3	–	1	9	1	–
[illegible]	Barre,	09	6	–	–	–	4	1	19	–	–	4	4	–
140	Medfield,	64	–	–	–	–	3	–	14	–	23	33	77	1
141	Somerset,	49	1	–	–	–	4	–	–	–	8	11	2	–
142	Blackstone,	95	–	–	1	–	9	–	–	–	–	11	–	–
143	Foxborough,	85	6	–	–	–	2	1	14	–	1	10	66	–
144	Hardwick,	41	–	–	–	–	–	–	3	–	–	1	1	–
145	Oxford,	60	2	–	–	–	7	–	14	–	–	6	2	1
146	Billerica,	53	–	–	1	–	–	–	3	–	3	4	6	1
147	Westport,	76	–	–	–	–	–	–	2	–	11	2	28	–
148	Leicester,	77	1	–	–	–	–	–	–	–	4	13	4	1
149	Lenox,	58	–	–	–	–	3	–	1	–	–	4	4	–
150	Shrewsbury,	39	–	–	–	–	–	–	1	–	22	11	–	–
151	Nantucket,	97	11	–	–	–	–	–	4	–	3	–	1	–
152	Manchester,	19	30	–	–	–	–	–	94	–	–	6	85	–
153	Hadley,	93	–	–	–	–	2	–	–	–	2	6	–	–
154	Deerfield,	79	–	–	–	–	6	–	1	–	1	9	2	–
155	West Bridgewater,	69	–	–	–	–	1	–	–	–	1	1	–	–
156	Hatfield,	44	3	–	–	–	5	–	27	–	9	2	1	–
157	Holbrook,	32	1	–	1	–	–	–	2	–	–	3	2	–
158	Seekonk,	05	–	–	–	–	1	–	–	–	–	2	–	–
159	Hopedale,	60	–	–	–	–	4	1	2	–	1	4	56	1
160	Medway,	42	–	–	–	–	–	1	6	–	–	4	9	–
161	Cohasset,	88	4	–	–	–	9	–	12	–	8	4	83	–
162	Swansea,	30	–	–	–	–	–	–	–	–	9	4	12	–
163	Pepperell,	12	–	–	–	–	–	–	14	–	–	8	22	–

to the Public Health, 1918 — Continued.

19C Mumps.		38A Ophthalmia Neonatorum.		7 Scarlet Fever.		28-29 Tuberculosis, Pulmonary.		30-35 Tuberculosis, Other Forms.		1 Typhoid Fever.		8 Whooping Cough.		106 Septic Sore Throat.		75A Trachoma.		38C Gonorrhœa.		37 Syphilis.		
Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Line No.
-	-	-	-	4	-	2	6	-	-	-	1	-	1	-	-	-	-	-	-	-	-	104
12	-	4	-	8	-	6	7	11	8	-	-	62	-	-	-	-	-	12	-	1	-	105
15	-	15	-	6	-	9	6	-	-	2	-	11	-	3	-	-	-	7	-	3	-	106
16	-	1	-	8	-	8	6	2	2	3	-	56	2	1	-	-	-	3	-	-	-	107
2	-	4	-	5	-	8	9	-	1	3	-	22	-	-	-	-	-	1	-	-	-	108
14	-	-	-	3	-	6	4	1	1	-	-	25	-	-	-	-	-	10	-	3	-	109
3	-	2	-	4	-	3	-	-	-	9	1	1	-	-	-	-	-	8	-	1	-	110
-	-	3	-	9	-	7	3	-	1	1	-	11	5	-	-	-	-	6	-	-	-	111
53	-	10	-	-	-	8	3	-	-	6	1	12	-	-	-	-	-	-	-	-	-	112
20	-	1	-	5	-	3	7	-	1	1	-	33	2	-	-	-	-	1	-	1	-	113
-	-	-	-	1	-	3	3	-	-	2	-	-	-	-	-	-	-	5	-	3	1	114
-	-	-	-	1	-	4	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	115
16	-	1	-	2	-	3	3	1	2	2	-	33	-	-	-	-	-	3	-	-	-	116
1	-	-	-	9	-	4	9	-	-	3	1	-	2	-	-	-	-	-	-	-	-	117
4	-	-	-	1	-	2	4	-	-	-	-	4	1	-	-	-	-	-	-	-	-	118
-	-	1	-	10	-	3	3	-	-	-	-	8	-	-	-	-	-	-	-	-	-	119
2	-	-	-	3	-	1	1	-	1	-	-	1	1	-	-	-	-	-	-	-	-	120
42	-	-	-	14	-	3	2	-	1	2	-	21	-	2	-	-	-	14	-	2	-	121
2	-	-	-	-	-	24	23	-	1	-	-	14	-	1	-	-	-	3	-	6	-	122
-	-	2	-	-	-	2	3	-	-	2	-	-	-	-	-	-	-	1	-	3	-	123
-	-	-	-	4	-	8	5	-	-	3	1	-	1	-	-	-	-	3	-	-	-	124
-	-	-	-	-	-	4	4	-	1	2	-	-	2	-	-	-	-	4	-	-	-	125
201	-	*12*	-	*281*	*5*	*149*	*191*	*7*	*33*	*73*	*9*	*182*	*24*	*11*	-	-	-	*77*	-	*35*	*8*	126
-	-	-	-	2	-	2	5	1	2	5	-	-	-	-	-	-	-	1	-	1	-	127
-	-	2	-	2	-	4	2	2	1	3	1	-	-	-	-	-	-	1	-	-	-	128
-	-	-	-	-	-	-	4	-	-	2	-	1	-	-	-	-	-	3	-	-	-	129
8	-	1	-	-	-	4	2	-	-	-	-	37	-	-	-	-	-	-	-	-	-	130
-	-	-	-	1	-	-	3	-	-	-	-	-	3	-	-	-	-	-	-	1	-	131
-	-	1	-	-	-	1	3	-	-	-	-	1	3	-	-	-	-	3	-	-	-	132
4	-	-	-	2	-	3	1	-	2	-	-	18	2	-	-	-	-	-	-	2	1	133
2	-	2	-	-	-	3	7	-	2	2	-	-	-	-	-	-	-	6	-	1	-	134
3	-	-	-	8	-	4	5	-	2	-	-	-	-	-	-	-	-	3	-	2	-	135
3	-	-	-	10	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	3	-	136
-	-	1	-	2	-	28	10	-	3	2	-	-	-	-	-	-	-	5	-	-	-	137
-	-	-	-	4	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	138
11	-	-	-	1	-	2	4	-	-	-	-	5	-	-	-	-	-	-	-	-	-	139
1	-	-	-	7	-	8	35	-	1	-	-	-	-	-	-	-	-	2	-	1	3	140
1	-	1	-	9	-	4	2	-	1	1	-	-	4	-	-	-	-	-	-	-	-	141
-	-	-	-	-	-	2	5	-	2	1	-	-	-	-	-	-	-	1	-	-	-	142
33	-	-	-	2	-	5	8	-	-	3	-	-	-	1	-	-	-	9	-	1	-	143
-	-	-	-	28	2	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	144
-	-	-	-	-	-	1	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	145
1	-	1	-	23	1	1	2	-	-	2	-	-	1	-	-	-	-	5	-	-	-	146
21	-	-	-	-	-	1	5	-	-	1	-	2	-	-	-	-	-	3	-	-	-	147
-	-	-	-	-	-	-	4	-	1	1	1	-	1	-	-	-	-	2	-	1	-	148
-	-	-	-	3	-	2	5	-	1	1	-	-	-	1	-	-	-	-	-	-	-	149
-	-	-	-	1	1	-	-	-	1	-	-	-	1	-	-	-	-	1	-	-	-	150
-	-	-	-	1	-	2	3	-	-	2	-	-	-	-	-	-	-	-	-	-	-	151
-	-	-	-	5	-	-	2	-	1	-	-	11	-	-	-	-	-	1	-	1	-	152
-	-	-	-	-	-	4	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	153
-	-	-	-	3	-	1	1	-	-	-	-	1	1	-	-	-	-	-	-	-	1	154
-	-	-	-	4	-	1	1	-	-	2	-	-	-	-	-	-	-	-	-	-	-	155
1	-	-	-	5	-	3	2	1	1	-	-	3	-	-	-	-	-	1	-	-	-	156
13	-	-	-	-	-	2	4	-	-	2	1	4	-	-	-	-	-	-	-	1	-	157
-	-	-	-	1	-	1	1	-	-	-	1	-	1	-	-	-	-	-	-	-	-	158
-	-	-	-	3	-	-	1	-	2	-	-	2	-	-	-	-	-	1	-	-	-	159
-	-	-	-	-	-	-	3	-	-	1	-	2	-	-	-	-	-	-	-	-	-	160
1	-	1	-	1	-	1	1	-	1	4	-	7	-	-	-	-	-	1	-	1	-	161
3	-	-	-	2	-	3	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	162
2	-	-	-	4	-	1	3	-	-	1	1	-	-	-	-	-	-	-	-	-	-	163

Cases and Deaths from Diseases Dangerous

Line No.	Cities and Towns grouped in Order of Population.	Population estimated as of July 1, 1918.	10A Chicken Pox.		61A Ep. Cerebrospinal Meningitis.		9 Diphtheria.		12B German Measles.		92 Lobar Pneumonia.		6 Measles.	
			Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
164	Hanover,	64	2	–	–	–	–	–	–	–	–	9	2	–
165	North Brookfield,	64	–	–	–	–	–	–	–	–	–	1	11	–
166	Wrentham,	44	23	–	–	–	2	–	118	–	36	6	19	–
167	Holliston,	37	1	–	–	–	1	–	14	–	–	4	1	1
168	Westford,	37	4	–	–	–	5	–	4	–	6	10	140	1
169	Acushnet,	33	–	–	–	1	3	–	1	–	–	9	3	–
170	Bourne,	00	10	–	–	–	–	–	–	–	2	12	11	–
171	Scituate,	77	2	–	–	–	7	–	6	–	–	6	13	–
172	Ayer,	67	5	–	–	–	–	–	62	–	6	7	60	3
173	Holden,	49	4	–	–	–	7	1	58	–	19	3	[illegible]	–
174	Dighton,	[illegible]	–	–	–	–	–	–	–	–	1	2	4	–
175	Sutton,	69	7	–	1	–	4	1	1	–	1	3	8	–
176	Kingston,	[illegible]	–	–	–	–	–	–	–	–	–	7	–	–
177	Lancaster,	[illegible]	16	–	–	–	1	–	26	–	2	3	34	–
178	Wilbraham,	[illegible]	–	–	–	–	1	–	–	–	1	1	6	–
179	Wilmington,	[illegible]	16	–	–	–	4	–	17	–	–	3	40	1
180	Norton,	46	1	–	–	–	–	–	–	–	1	3	–	–
1[illegible]	Sharon,	70	1	–	–	–	–	–	9	–	–	6	6	–
182	*Towns under 2,500.*	*218,580*	[illegible]	–	*4*	*4*	*158*	*9*	*500*	–	*384*	*306*	*1,104*	*19*
183	Weston,	2,493	6	–	–	–	1	–	10	–	3	–	29	–
184	Hopkinton,	2,490	1	–	–	–	–	–	6	–	1	2	76	–
185	Groveland,	2,457	12	–	–	–	–	–	1	–	10	6	16	–
186	Groton,	2,448	–	–	–	–	–	–	–	–	–	2	–	–
187	Hull,	2,409	2	–	–	–	2	–	6	–	6	5	46	–
188	Rehoboth,	2,373	–	–	–	–	–	–	–	–	3	3	3	–
189	Charlton,	2,329	–	–	–	–	2	1	–	–	–	9	27	1
190	Shirley,	2,322	1	–	–	–	8	–	2	–	27	8	74	–
191	Avon,	2,300	55	–	–	–	–	–	–	–	–	3	13	–
192	Harwich,	2,220	–	–	–	–	1	–	1	–	–	4	1	–
193	Ashland,	2,213	1	–	–	–	–	1	31	–	1	4	134	1
194	Douglas,	2,196	4	–	–	–	3	–	4	–	–	3	7	–
195	East Longmeadow,	2,188	–	–	–	–	–	–	3	–	9	5	–	–
196	Acton,	2,161	7	–	–	–	1	–	–	–	–	2	7	–
197	Georgetown,	2,122	5	–	–	–	5	–	1	–	5	6	[illegible]	1
198	Bellingham,	2,117	–	–	–	–	–	–	1	–	–	3	10	–
199	Williamsburg,	2,109	2	–	–	–	14	–	–	–	1	1	8	–
200	Duxbury,	2,071	6	–	–	–	–	–	15	–	–	1	2	–
201	Belchertown,	2,068	–	–	–	–	13	–	–	–	–	3	4	–
202	Merrimac,	2,037	–	–	–	–	1	–	–	–	18	11	7	1
203	Ashburnham,	2,027	–	–	–	–	1	–	20	–	15	3	20	2
204	Millville,	2,026	–	–	–	–	2	–	–	–	7	–	–	–
205	Upton,	2,014	1	–	–	–	2	–	4	–	4	3	41	1
206	Southborough,	1,997	5	–	–	–	2	–	–	–	–	3	36	–
207	Rutland,	1,992	–	–	–	–	–	–	–	–	–	7	1	–
208	Brookfield,	1,966	–	–	–	–	–	–	25	–	6	3	–	–
209	Hamilton,	1,962	–	–	–	–	–	–	–	–	–	2	3	–
210	Wayland,	1,921	–	–	1	–	1	1	7	–	–	4	8	–
211	Sheffield,	1,891	2	–	–	–	–	–	–	–	6	2	1	–
212	Colrain,	1,886	–	–	–	–	–	–	–	–	1	3	1	–
213	Stockbridge,	1,881	2	–	–	–	1	–	3	–	2	–	8	–
214	Northfield,	1,872	–	–	–	–	8	–	21	–	–	6	9	–
215	Sherborn,	1,869	–	–	–	–	1	–	8	–	5	1	5	–
216	Raynham,	1,865	–	–	–	–	–	–	–	–	1	3	4	–
217	Northborough,	1,851	1	–	1	1	1	–	2	–	–	2	12	–
218	Longmeadow,	1,846	3	–	–	–	2	–	13	–	1	2	9	–
219	Townsend,	1,844	5	–	–	–	1	–	–	–	–	–	4	–
220	Freetown,	1,786	3	–	–	–	–	–	–	–	1	–	–	–
221	Dennis,	1,761	–	–	–	–	–	–	6	–	3	1	–	–
222	Hanson,	1,758	–	–	1	1	1	–	–	–	–	1	–	–
223	Salisbury,	1,755	–	–	–	–	–	–	–	–	1	2	6	2

to the Public Health, 1918 — Continued.

19C		32A		7		28-29		30-35		1		8		106		75A		38C		37		
Mumps.		Ophthalmia Neonatorum.		Scarlet Fever.		Tuberculosis, Pulmonary.		Tuberculosis, Other Forms.		Typhoid Fever.		Whooping Cough.		Septic Sore Throat.		Trachoma.		Gonorrhœa.		Syphilis.		
Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Line No.
-	-	-	-	-	-	-	2	-	-	1	-	16	-	-	-	-	-	5	-	1	1	164
-	-	-	-	-	-	1	3	-	-	15	1	-	1	-	-	-	-	-	-	-	-	165
-	-	-	-	1	-	6	4	-	-	1	-	-	-	-	-	-	-	2	-	-	-	166
-	-	-	-	99	1	1	3	-	-	-	-	-	-	9	-	-	-	-	-	1	-	167
-	-	-	-	-	-	7	3	-	-	-	-	1	1	-	-	-	-	1	-	3	-	168
1	-	1	-	-	-	5	1	-	1	-	-	-	-	-	-	-	-	1	-	-	-	169
20	-	-	-	1	-	3	9	-	-	-	-	5	-	-	-	-	-	6	-	3	1	170
3	-	-	-	11	-	1	2	-	-	1	-	5	-	-	-	-	-	2	-	-	-	171
2	-	-	-	1	-	3	-	-	-	3	-	11	-	-	-	-	-	9	-	6	-	172
9	-	-	-	23	-	3	-	2	2	1	-	3	-	-	-	-	-	-	-	1	-	173
-	-	-	-	1	-	3	5	1	1	1	2	-	-	-	-	-	-	-	-	2	-	174
-	-	1	-	-	-	5	1	-	-	-	-	15	2	-	-	-	-	-	-	1	-	175
-	-	-	-	-	-	1	1	-	1	1	-	-	-	-	-	-	-	-	-	1	-	176
53	-	-	-	-	-	2	2	-	2	1	-	24	-	-	-	-	-	-	-	-	-	177
4	-	-	-	2	-	-	3	-	1	-	-	-	-	-	-	-	-	-	-	-	-	178
-	-	-	-	3	-	-	2	-	1	10	1	-	-	-	-	-	-	1	-	-	-	179
-	-	-	-	-	-	-	3	-	-	1	-	-	-	-	-	-	-	-	-	-	1	180
1	-	-	-	5	-	11	4	-	-	1	-	7	1	-	-	-	-	-	-	-	-	181
177	-	*11*	-	*265*	*5*	*141*	*392*	*9*	*18*	*50*	*5*	*292*	*23*	*7*	*2*	-	-	*544*	-	*222*	*6*	182
-	-	-	-	1	-	3	2	1	1	2	-	42	-	-	-	-	-	2	-	-	-	183
-	-	-	-	2	-	3	6	-	-	-	-	-	-	-	-	-	-	2	-	-	1	184
-	-	-	-	2	-	6	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	185
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	186
17	-	-	-	8	1	4	1	-	-	1	-	4	-	3	-	-	-	4	-	-	-	187
1	-	-	-	2	1	-	1	-	-	-	-	4	1	-	-	-	-	-	-	-	-	188
-	-	-	-	-	-	3	1	1	-	5	-	-	-	-	-	-	-	-	-	-	-	189
1	-	-	-	3	-	1	2	-	-	-	-	6	-	-	-	-	-	-	-	-	-	190
2	-	-	-	1	-	3	2	-	-	-	-	92	1	-	-	-	-	-	-	-	-	191
-	-	-	-	1	-	3	3	-	-	1	-	-	-	-	-	-	-	1	-	-	-	192
-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	193
-	-	1	-	2	-	2	4	-	2	-	-	3	-	-	-	-	-	7	-	-	-	194
-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	195
-	-	-	-	5	-	-	1	1	-	-	-	4	3	-	-	-	-	1	-	-	-	196
1	-	-	-	-	-	2	3	-	-	-	-	-	-	-	-	-	-	3	-	2	-	197
-	-	-	-	3	-	1	1	-	-	-	-	8	1	-	-	-	-	-	-	-	-	198
4	-	-	-	2	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	199
28	-	-	-	-	-	3	1	-	-	1	-	10	-	-	-	-	-	-	-	-	-	200
1	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	201
-	-	-	-	-	-	-	1	-	2	-	-	11	1	-	-	-	-	1	-	1	1	202
-	-	-	-	2	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	203
-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	204
-	-	-	-	1	-	5	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	205
-	-	-	-	3	-	3	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	206
-	-	-	-	-	-	-	102	-	1	-	-	-	-	-	-	-	-	-	-	-	-	207
-	-	-	-	-	-	3	2	-	1	3	-	3	-	-	-	-	-	-	-	-	-	208
-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	209
-	-	-	-	-	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	210
-	-	-	-	2	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	211
2	-	-	-	30	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	212
1	-	-	-	-	-	-	2	-	1	-	-	4	-	-	-	-	-	-	-	-	-	213
36	-	-	-	2	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	214
-	-	-	-	2	-	3	-	-	-	1	1	1	1	-	-	-	-	483	-	213	-	215
-	-	-	-	2	-	4	4	-	1	-	-	-	-	-	-	-	-	-	-	-	-	216
-	-	-	-	6	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	217
4	-	1	-	2	-	1	2	-	-	1	-	3	-	-	-	-	-	1	-	-	2	218
-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	219
-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	1	-	-	-	220
3	-	1	-	4	-	2	2	-	-	-	-	-	-	-	-	-	-	1	-	-	-	221
-	-	-	-	1	-	1	2	1	1	-	-	-	-	-	-	-	-	-	-	1	-	222
-	-	-	-	1	-	-	2	-	-	2	1	-	-	-	-	-	-	-	-	-	-	223

Cases and Deaths from Diseases Dangerous

Line No.	Cities and Towns grouped in Order of Population.	Population estimated as of July 1, 1918.	19A Chicken Pox. Cases.	19A Chicken Pox. Deaths.	61A Ep. Cerebrospinal Meningitis. Cases.	61A Ep. Cerebrospinal Meningitis. Deaths.	9 Diphtheria. Cases.	9 Diphtheria. Deaths.	19B German Measles. Cases.	19B German Measles. Deaths.	92 Lobar Pneumonia. Cases.	92 Lobar Pneumonia. Deaths.	6 Measles. Cases.	6 Measles. Deaths.
224	Lunenburg,	1,748	43	-	-	-	-	-	41	-	2	1	6	2
225	Westminster,	1,748	-	-	-	-	1	-	-	-	-	4	-	-
226	Chatham,	1,734	-	-	-	-	1	-	2	-	-	5	1	-
227	Carver,	1,726	-	-	-	-	-	-	-	-	-	2	-	-
228	Marshfield,	1,716	16	-	-	-	2	1	8	-	2	2	5	-
229	Lakeville,	1,715	-	-	-	-	1	-	1	-	4	3	-	-
230	Essex,	1,713	-	-	-	-	2	-	-	-	-	-	15	-
231	Norwell,	1,662	1	-	-	-	-	-	1	-	5	6	6	-
232	Newbury,	1,660	-	-	-	-	-	-	1	-	-	2	34	-
233	Southwick,	1,586	-	-	-	-	1	1	-	-	-	3	1	-
234	Buckland,	1,566	1	-	-	-	4	-	-	-	2	8	-	-
235	West Newbury,	1,565	1	-	-	-	1	-	-	-	10	4	2	-
236	Westwood,	1,564	-	-	-	-	2	-	-	-	-	-	-	-
237	Cheshire,	1,555	-	-	-	-	-	-	-	-	-	-	-	-
238	Rowley,	1,554	-	-	-	-	-	-	1	-	-	5	5	-
239	Nahant,	1,518	2	-	-	-	-	-	8	-	5	4	-	-
240	Marion,	1,503	1	-	-	-	-	-	3	-	9	9	15	-
241	Shelburne,	1,474	1	-	-	-	8	-	1	-	2	2	-	-
242	Millis,	1,470	-	-	-	-	-	-	-	-	-	-	62	-
243	Norfolk,	1,466	2	-	-	-	-	-	2	-	2	1	-	-
244	Bedford,	1,451	1	-	-	-	2	-	-	-	-	1	2	-
245	North Reading,	1,442	5	-	-	-	-	-	14	-	4	2	5	-
246	Sterling,	1,432	-	-	-	-	-	-	15	-	3	1	2	-
247	Mattapoisett,	1,429	11	-	-	-	1	-	-	-	2	-	3	-
248	Sunderland,	1,426	-	-	-	-	-	-	-	-	3	9	-	-
249	Plainville,	1,424	1	-	-	-	1	-	1	-	-	3	-	-
250	Middleton,	1,423	-	-	-	-	1	-	-	-	-	1	-	-
251	Yarmouth,	1,412	1	-	-	-	-	-	-	-	1	2	1	-
252	Tisbury,	1,407	4	-	-	-	3	-	12	-	9	4	8	-
253	Sturbridge,	1,400	1	-	-	-	-	-	-	-	-	3	1	-
254	Lincoln,	1,397	-	-	-	-	-	-	-	-	-	-	-	-
255	Huntington,	1,396	-	-	-	-	1	-	-	-	-	2	-	-
256	Sandwich,	1,378	2	-	-	-	4	1	-	-	2	4	4	-
257	West Boylston,	1,350	7	-	-	-	-	-	6	-	-	6	4	-
258	Oak Bluffs,	1,348	-	-	-	-	-	-	-	-	2	3	-	-
259	Hinsdale,	1,347	-	-	-	-	-	-	-	-	-	1	-	-
260	Pembroke,	1,337	-	-	-	-	-	-	-	-	-	-	-	-
261	Edgartown,	1,331	2	-	-	-	-	-	3	-	5	-	-	-
262	Chester,	1,322	-	-	-	-	-	-	-	-	-	2	-	-
263	Whately,	1,292	-	-	-	-	6	1	-	-	-	3	1	-
264	West Stockbridge,	1,280	-	-	-	-	-	-	-	-	-	-	-	-
265	West Brookfield,	1,263	-	-	-	-	-	-	2	-	-	2	20	1
266	Sudbury,	1,261	4	-	-	-	1	-	-	-	-	4	11	-
267	Lynnfield,	1,241	-	-	-	1	-	-	-	-	-	-	-	-
268	Littleton,	1,228	20	-	-	-	1	-	6	-	3	-	5	-
269	Orleans,	1,224	-	-	-	-	1	-	10	-	2	1	22	-
270	Conway,	1,214	-	-	-	-	1	-	1	-	-	4	1	-
271	Rochester,	1,205	-	-	-	-	1	-	-	-	-	-	-	-
272	Russell,	1,194	-	-	-	-	-	-	-	-	1	1	1	-
273	Erving,	1,181	1	-	-	-	1	-	10	-	7	6	2	-
274	Lanesborough,	1,179	-	-	-	-	-	-	-	-	-	-	-	-
275	Topsfield,	1,178	-	-	-	-	-	-	7	-	1	2	1	-
276	Harvard,	1,149	1	-	-	-	-	1	-	-	3	8	5	6
277	Stow,	1,134	-	-	-	1	-	-	-	-	-	5	24	-
278	Dover,	1,128	1	-	-	-	-	-	2	-	-	-	4	-
279	Wenham,	1,106	-	-	-	-	-	-	-	-	-	1	-	-
280	Hubbardston,	1,091	-	-	-	-	2	-	-	-	4	1	1	-
281	Tyngsborough,	1,056	-	-	-	-	-	-	4	-	4	-	3	-
282	Clarksburg,	1,054	-	-	-	-	-	-	-	-	-	1	-	-
283	Ashfield,	1,016	-	-	-	-	-	-	-	-	-	-	-	-
284	Southampton,	1,001	1	-	-	-	-	-	-	-	-	1	2	-
285	Becket,	982	-	-	-	-	2	-	-	-	2	3	-	-
286	Brimfield,	978	-	-	-	-	-	-	1	-	1	1	1	-

to the Public Health, 1918 — Continued.

19C Mumps.		33A Ophthalmia Neonatorum.		7 Scarlet Fever.		28-29 Tuberculosis, Pulmonary.		30-35 Tuberculosis, Other Forms.		1 Typhoid Fever.		8 Whooping Cough.		100 Septic Sore Throat.		75A Trachoma.		33C Gonorrhœa.		37 Syphilis.		
Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Line No.
-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	224
-	-	-	-	-	-	-	-	-	-	2	-	-	1	-	-	-	-	-	-	-	-	225
-	-	1	-	1	-	-	-	-	-	-	-	1	2	-	-	-	-	-	-	-	-	226
-	-	-	-	-	-	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	227
3	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	228
-	-	-	-	1	-	1	92	-	-	1	-	1	-	-	-	-	-	-	-	-	1	229
-	-	-	-	3	-	-	3	-	-	-	-	4	-	-	-	-	-	-	-	1	-	230
-	-	1	-	-	-	1	2	-	-	-	-	5	-	-	-	-	-	-	-	-	-	231
-	-	-	-	4	1	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	232
-	-	-	-	-	-	-	1	-	-	2	1	-	-	-	-	-	-	-	-	-	-	233
-	-	-	-	4	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	234
1	-	-	-	1	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	235
-	-	-	-	-	-	1	2	1	1	-	-	-	1	-	-	-	-	-	-	-	-	236
-	-	-	-	4	1	4	5	-	-	1	-	-	-	-	-	-	-	1	-	-	-	237
-	-	-	-	-	-	1	1	-	-	12	1	2	-	-	-	-	-	-	-	-	-	238
-	-	-	-	-	-	-	1	-	-	1	-	-	1	-	-	-	-	-	-	-	-	239
-	-	-	-	8	-	3	1	-	-	-	-	3	-	-	-	-	-	-	-	-	-	240
-	-	-	-	8	-	3	2	-	-	-	-	-	-	-	-	-	-	4	-	-	-	241
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-	-	-	-	2	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	1	-	243
1	-	-	-	4	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	-	-	244
-	-	-	-	5	-	2	55	-	-	1	-	-	-	-	-	-	-	2	-	-	-	245
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4	-	-	-	2	-	1	1	-	-	-	-	-	-	-	-	-	-	1	-	-	-	247
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-	-	-	-	-	-	1	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	257
-	-	-	-	1	-	3	2	-	1	1	-	1	-	-	-	-	-	-	-	-	-	258
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-	-	-	-	-	-	4	2	-	-	2	-	1	-	-	-	-	-	2	-	-	-	261
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3	-	-	-	1	-	1	4	-	1	1	1	-	2	-	-	-	-	-	-	-	-	265
-	-	-	-	1	-	-	1	-	-	1	-	-	1	-	-	-	-	-	-	-	-	266
-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	267
2	-	-	-	-	-	2	2	-	-	-	-	9	-	-	-	-	-	-	-	-	-	268
1	-	-	-	6	-	2	-	-	-	1	-	2	-	-	-	-	-	1	-	-	-	269
-	-	-	-	2	-	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	270
-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	271
-	-	-	-	1	-	-	-	-	-	3	-	4	-	-	-	-	-	-	-	-	-	272
42	-	-	-	21	-	1	1	-	-	-	-	6	-	-	-	-	-	-	-	-	-	273
-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	274
1	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	275
-	-	-	-	-	-	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	276
1	-	-	-	2	-	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	277
1	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	278
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	279
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-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	281
-	-	-	-	1	-	-	4	-	-	-	-	7	1	-	-	-	-	-	-	-	-	282
-	-	-	-	2	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	283
-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	284
-	-	-	-	6	-	2	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	285
-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	286

Cases and Deaths from Diseases Dangerous

Line No.	Cities and Towns grouped in Order of Population.	Population estimated as of July 1, 1918.	19A Chicken Pox.		61A Ep. Cerebrospinal Meningitis.		9 Diphtheria.		19B German Measles.		92 Lobar Pneumonia.		6 Measles.	
			Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
287	Berkley,	976	-	-	-	-	-	-	-	-	-	-	-	-
288	New Marlborough,	969	-	-	-	-	-	-	-	-	2	-	8	-
289	Mendon,	968	-	-	-	-	-	-	-	-	-	2	-	-
290	Charlemont,	961	-	-	-	-	-	-	-	-	4	3	-	-
291	Gill,	957	-	-	-	-	1	-	105	-	-	2	3	-
292	Ashby,	945	-	-	-	-	15	-	2	-	-	3	-	-
293	Royalston,	907	-	-	-	-	-	-	6	-	-	-	-	-
294	Wellfleet,	881	2	-	-	-	-	-	1	-	6	-	-	-
295	Brewster,	880	-	-	-	-	-	-	-	-	-	-	2	-
296	Granby,	870	-	-	-	-	-	-	-	-	-	2	-	-
297	Burlington,	854	-	-	-	-	-	-	-	-	2	1	9	-
298	Berlin,	838	-	-	-	-	1	-	-	-	-	-	1	-
299	Boylston,	828	-	-	-	-	-	-	-	-	4	3	-	-
300	Bernardston,	822	-	-	-	-	-	-	-	-	1	-	-	-
301	Leverett,	811	-	-	-	-	-	-	-	-	2	4	12	-
302	Princeton,	788	-	-	-	-	1	-	-	-	2	2	-	-
303	Granville,	787	-	-	-	-	-	-	-	-	-	1	-	-
304	Bolton,	771	2	-	-	-	-	-	3	-	-	1	7	-
305	Enfield,	762	3	-	-	-	-	-	1	-	1	2	3	1
306	Boxford,	711	-	-	1	-	-	-	1	-	2	3	-	-
307	Petersham,	708	-	-	-	-	-	-	3	-	-	-	1	-
308	Dana,	696	-	-	-	-	1	-	-	-	1	-	-	-
309	Halifax,	695	-	-	-	-	-	-	-	-	-	-	-	-
310	Hampden,	686	-	-	-	-	1	1	1	-	2	1	1	-
311	Cummington,	676	-	-	-	-	-	-	-	-	-	-	-	-
312	Truro,	669	-	-	-	-	1	-	8	-	2	2	-	-
313	Worthington,	650	-	-	-	-	-	-	-	-	-	-	-	-
314	Plympton,	624	-	-	-	-	-	-	-	-	-	-	-	-
315	New Salem,	616	-	-	-	-	1	-	-	-	-	-	2	-
316	Egremont,	596	-	-	-	-	-	-	-	-	-	-	8	-
317	Chesterfield,	575	5	-	-	-	-	-	-	-	-	-	18	-
318	Sandisfield,	563	-	-	-	-	-	-	-	-	-	-	-	-
319	Blandford,	562	-	-	-	-	3	-	-	-	1	2	18	1
320	Eastham,	562	-	-	-	-	-	-	-	-	-	3	-	-
321	Hancock,	546	-	-	-	-	-	-	-	-	-	-	-	-
322	Savoy,	538	-	-	-	-	-	-	-	-	-	-	-	-
323	Pelham,	519	-	-	-	-	-	-	1	-	2	-	-	-
324	Oakham,	511	-	-	-	-	-	-	2	-	-	1	1	-
325	Richmond,	509	-	-	-	-	1	-	-	-	-	-	-	-
326	Paxton,	506	-	-	-	-	-	-	-	-	-	1	-	-
327	Warwick,	477	-	-	-	-	-	-	-	-	-	-	-	-
328	Carlisle,	451	-	-	-	-	-	-	-	-	1	1	-	-
329	Florida,	447	-	-	-	-	-	-	-	-	-	-	-	-
330	New Braintree,	446	-	-	-	-	-	-	-	-	-	1	4	-
331	West Tisbury,	444	1	-	-	-	3	-	2	-	1	-	-	-
332	Westhampton,	434	-	-	-	-	-	-	-	-	-	1	1	-
333	Hawley,	430	-	-	-	-	-	-	-	-	-	-	-	-
334	Greenwich,	410	7	-	-	-	-	-	-	-	1	3	8	-
335	Otis,	410	-	-	-	-	-	-	-	-	-	-	-	-
336	Heath,	406	1	-	-	-	-	-	-	-	-	-	-	-
337	Rowe,	404	6	-	-	-	-	-	-	-	2	2	-	-
338	Phillipston,	367	-	-	-	-	-	-	-	-	-	-	-	-
339	Leyden,	357	-	-	-	-	-	-	1	-	3	1	-	-
340	Plainfield,	356	-	-	-	-	-	-	-	-	-	-	-	-
341	Windsor,	356	-	-	-	-	-	-	-	-	-	-	-	-
342	Monterey,	339	-	-	-	-	-	-	-	-	1	-	-	-
343	Dunstable,	333	-	-	-	-	1	-	-	-	-	-	-	-
344	Boxborough,	332	-	-	-	-	-	-	-	-	-	1	2	-
345	Wales,	331	-	-	-	-	2	-	-	-	-	2	6	-
346	Monroe,	328	-	-	-	-	-	-	-	-	-	-	1	-
347	Wendell,	315	-	-	-	-	-	-	-	-	2	2	-	-
348	Shutesbury,	308	-	-	-	-	-	-	-	-	1	1	1	-
349	Middlefield,	306	-	-	-	-	-	-	-	-	-	-	-	-

to the Public Health, 1918 — Continued.

19C Mumps.		32A Ophthalmia Neonatorum.		7 Scarlet Fever.		28-29 Tuberculosis, Pulmonary.		30-35 Tuberculosis, Other Forms.		1 Typhoid Fever.		8 Whooping Cough.		100 Septic Sore Throat.		75A Trachoma.		38C Gonorrhœa.		37 Syphilis.		
Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Line No.
-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	287
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	288
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	289
-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	290
3	-	-	-	31	-	-	-	-	-	-	-	6	-	2	-	-	-	-	-	-	-	291
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	292
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	293
-	-	-	-	1	-	2	1	-	-	-	-	1	-	-	-	-	-	1	-	-	-	294
-	-	-	-	8	-	1	2	-	-	-	-	-	-	-	1	-	-	1	-	-	-	295
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1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	305
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-	-	1	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	309
-	-	-	-	6	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	310
-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	311
-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	312
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	313
-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	314
-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	315
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	316
-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	317
-	-	-	-	5	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	318
-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	319
-	-	-	-	-	-	1	1	-	-	-	-	3	-	-	-	-	-	-	-	-	-	320
-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	321
2	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	322
-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	323
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	324
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	325
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	326
4	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	327
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	328
-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	329
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	330
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	331
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	332
-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	333
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	334
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	335
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	336
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	337
-	-	-	-	7	-	-	-	-	1	-	-	7	-	-	-	-	-	-	-	-	-	338
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	339
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	340
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	341
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	342
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	343
-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	344
-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	345
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	346
-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	347
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	348
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	349

Cases and Deaths from Diseases Dangerous

Line No.	Cities and Towns grouped in Order of Population.	Population estimated as of July 1, 1918.	19A Chicken Pox.		61A Ep. Cerebro-spinal Meningitis.		9 Diphtheria.		19B German Measles.		92 Lobar Pneumonia.		6 Measles.	
			Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
350	Goshen,	295	-	-	-	-	-	-	-	-	-	-	-	-
351	Tyringham,	293	-	-	-	-	-	-	-	-	2	-	-	-
352	Chilmark,	292	-	-	-	-	-	-	-	-	-	1	-	-
353	Prescott,	286	-	-	-	-	-	-	-	-	2	2	1	-
354	Washington,	274	-	-	-	-	-	-	-	-	-	1	-	-
355	Alford,	268	-	-	-	-	-	-	-	-	-	-	16	-
356	Mashpee,	260	-	-	-	-	-	-	-	-	-	-	-	-
357	Montgomery,	239	-	-	-	-	-	-	-	-	-	1	-	-
358	Tolland,	212	-	-	-	-	-	-	-	-	-	-	-	-
359	Gay Head,	184	-	-	-	-	-	-	-	-	-	-	-	-
360	Peru,	169	-	-	-	-	-	-	-	-	-	-	-	-
361	Holland,	168	-	-	-	-	-	-	-	-	-	-	2	-
362	Gosnold,	158	-	-	-	-	-	-	-	-	-	-	-	-
363	New Ashford,	92	-	-	-	-	-	-	-	-	-	-	-	-
364	Mount Washington,	85	-	-	-	-	-	-	-	-	-	-	1	-
365	Camp Devens,	-	9	-	25	7	24	2	84	-	2584	720	907	6
366	State Infirmary,	-	44	1	-	-	18	-	-	-	12	18	82	15

In addition to the above there occurred 1 case of actinomycosis: —

	Cases.	Deaths.
Attleboro,	1	-

99 cases of anterior poliomyelitis, with 38 deaths: —

	Cases.	Deaths.
Barre,	1	-
Belmont,	1	-
Beverly,	1	1
Boston,	14	10
Braintree,	1	1
Brockton,	1	1
Cambridge,	5	2
Chelsea,	1	1
Cohasset,	1	-
Dedham,	2	1
Dracut,	1	-
Easthampton,	1	-
Everett,	1	-
Fairhaven,	1	-
Fall River,	2	-
Framingham,	3	1
Hadley,	1	-
Halifax,	1	-
Haverhill,	2	-
Holyoke,	5	1
Hopedale,	2	1
Lowell,	8	4
Malden,	1	1
Marlborough,	-	1
Medford,	3	-
Mendon,	1	1
Methuen,	1	-
Milford,	2	1
New Bedford,	11	-
Newton,	1	1
Northampton,	3	-
Quincy,	1	-
Revere,	2	1
Shirley,	1	-
Somerville,	3	-
Springfield,	4	1
Sterling,	1	1
Sutton,	-	1
Taunton,	1	-
Tewksbury,	-	1
Tewksbury State Infirmary,	-	1
Topsfield,	1	1
Ware,	1	-
Warren,	1	-
Wellesley,	-	1
Whately,	1	-
Whitman,	1	-
Winthrop,	1	-
Worcester,	1	1

23 cases of anthrax, with 7 deaths: —

	Cases.	Deaths.
Athol,	-	1
Camp Devens,	1	-
Bolton,	1	-
Boston,	3	-
Brockton,	1	1
Chicopee,	1	-
Haverhill,	2	-
Lawrence,	1	1
Lowell,	2	-
Lynn,	1	1
Methuen,	1	1
Peabody,	1	-
Quincy,	-	1
Salem,	1	-
Springfield,	-	1
Winchendon,	3	-
Winchester,	1	-
Woburn,	3	-

to the Public Health, 1918 — Concluded.

19C Mumps.		38A Ophthalmia Neonatorum.		7 Scarlet Fever.		28–29 Tuberculosis, Pulmonary.		30–35 Tuberculosis, Other Forms.		1 Typhoid Fever.		8 Whooping Cough.		100 Septic Sore Throat.		75A Trachoma.		38C Gonorrhœa.		37 Syphilis.		
Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Line No.
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	350
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	351
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	352
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	353
-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	354
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	355
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	356
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	357
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	358
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	359
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	360
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	361
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	362
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	363
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	364
1011	-	-	-	45	1	1	3	-	2	5	-	-	-	-	-	-	-	508	-	408	3	365
-	1	3	-	-	-	146	253	16	11	2	-	3	-	-	-	-	-	108	-	46	26	366

20 cases of dog bite (requiring antirabic treatment). On final investigation it was found that in only three cases was Pasteur treatment necessary.

	Cases.	Deaths.
Attleboro,	1	-
Barre,	3	-
Boston,	3	-
Charleton,	1	-
Clinton,	1	-
Lawrence,	1	-
Lowell,	1	-
Methuen,	1	-
North Attleborough,	3	-
Taunton,	2	-
Ware,	1	-
Worcester,	2	-

79 cases of dysentery, with 75 deaths: —

	Cases.	Deaths.
Adams,	1	-
Amesbury,	-	2
Andover,	1	-
Attleboro,	-	1
Beverly,	1	1
Bernardston,	-	1
Blackstone,	-	1
Boston,	11	4
Bridgewater,	-	1
Cambridge,	1	3
Chelsea,	-	1
Chicopee,	-	2
Danvers,	1	-
Dartmouth,	6	1
Dedham,	-	2
Dracut,	-	2
Easthampton,	-	3
Essex,	2	-
Fall River,	1	3
Gardner,	-	1
Greenfield,	2	-
Hamilton,	1	-
Haverhill,	-	1
Holyoke,	-	2
Ipswich,	2	-
Lawrence,	1	2
Leominster,	-	2
Lowell,	-	3
Malden,	-	2
Medfield,	7	1
Medway,	-	1
Melrose,	7	2
Middleborough,	2	-
Milford,	-	1
Montague,	-	1
New Bedford,	3	2
Newburyport,	1	2
North Adams,	2	3
Northampton,	-	2
Pelham,	1	1
Princeton,	-	1
Rowley,	-	1
Salem,	-	2
Scituate,	-	1
Shirley,	7	-
Somerville,	4	1
Springfield,	-	2
Sutton,	8	-
Swampscott,	-	1
Taunton,	-	3
Wakefield,	-	1
Waltham,	-	2
Wellesley,	-	1
Whitman,	-	1
Woburn,	-	1
Worcester,	6	-

3 cases of leprosy: —	Cases.	Deaths.
Boston,	3	–

82 cases of malaria, with 4 deaths: —	Cases.	Deaths.
Camp Devens,	10	–
Blackstone,	3	–
Boston,	13	–
Bridgewater,	1	–
Cambridge,	1	–
Dedham,	7	–
Erving,	3	–
Fall River,	3	–
Lynn,	5	–
Mansfield,	1	–
Melrose,	–	1
Natick,	4	–
Newton,	1	1
Pittsfield,	1	–
Springfield,	1	1
Uxbridge,	28	–
Westfield,	–	1

19 cases of pellagra, with 22 deaths: —	Cases.	Deaths.
Boston,	2	3
Boxford,	1	–
Cambridge,	1	–
Chelsea,	–	1
Danvers,	–	3
Everett,	1	1
Fall River,	–	1
Foxborough,	2	1
Gardner,	–	1
Leominster,	1	–
Lowell,	–	1
Lynn,	1	1
Middleton,	–	1
Northampton,	4	3
Somerville,	1	–
Stoneham,	–	1
Taunton,	1	–
Waltham,	1	1
Worcester,	3	3

27 cases of smallpox: —	Cases.	Deaths.
Camp Devens,	1	–
Boston,	6	–
Chelsea,	1	–
Gloucester,	2	–
Hardwick,	1	–
Lowell,	2	–
Lynn,	1	–
Marlborough,	6	–
Milton,	1	–
Natick,	1	–
Tewksbury State Infirmary,	2	–
Tisbury,	1	–
West Springfield,	2	–

27 cases of tetanus, with 32 deaths: —	Cases.	Deaths.
Andover,	–	1
Beverly,	1	–
Boston,	3	1
Brockton,	1	–
Cambridge,	2	–
Chesterfield,	1	–
Clinton,	–	1
Concord,	–	1
East Bridgewater,	–	1
Fall River,	1	1
Gloucester,	1	1
Great Barrington,	1	–
Lawrence,	2	3
Lowell,	–	1
Lynn,	–	1
Malden,	–	1
Mansfield,	–	1
Marion,	1	–
Northampton,	–	1
Peabody,	1	1
Pittsfield,	–	2
Plymouth,	1	1
Provincetown,	–	1
Salem,	2	3
Springfield,	1	1
Sudbury,	1	–
Taunton,	1	2
Wakefield,	1	–
Winchester,	–	1
Worcester,	5	5

15 cases of trichinosis: —	Cases.	Deaths.
Brockton,	5	–
Hingham,	1	–
Lynn,	1	–
Northampton,	8	–

2 cases of typhus, with 1 death: —	Cases.	Deaths.
Boston,	–	1
Chelsea,	2	–

Influenza was added to the list of reportable diseases on Oct. 4, 1918. From that date until the close of the year there were reported 145,262 cases, with 11,100 deaths. The distribution by months was as follows: —

October,	88,494	8,274
November,	14,750	1,022
December,	42,018	1,804

DIVISION OF BIOLOGIC LABORATORIES.

MILTON J. ROSENAU, M.D., *Director*.

REPORT OF DIVISION OF BIOLOGIC LABORATORIES.

The work of the Division of Biologic Laboratories was carried out in the face of unusual difficulties during the fiscal year 1918. This was caused by increased activities, increased demand for products, changes in personnel, the difficulty in obtaining certain supplies and the strain of finances caused by war conditions. Several emergencies had to be met which taxed the capacity of the laboratories to their utmost. There was a sudden and unusual demand for diphtheria antitoxin during the summer, for vaccine virus in the spring and for anti-meningitis serum during the cold season. The principal new activity of the Division consisted in the testing of arsphenamine.

The changes in personnel at the Antitoxin and Vaccine Laboratory at Forest Hills, caused by war conditions, became a matter of deep concern when the nature and importance of the products made at that laboratory are taken into account. The financial situation was bothersome throughout the fiscal year, for it soon became evident that even with the strictest economy it would be impossible to make the budget meet the increasing cost of labor and supplies.

As an example of the difficulties the laboratories had to contend with, we may cite the fact that it has become impossible to obtain dialyzing paper for the purpose of concentrating diphtheria antitoxin. This paper was formerly made in Belgium, and since this source of supply has been cut off, it has become practically unavailable.

The following is a summary of the work done both at the Antitoxin and Vaccine Laboratory at Forest Hills, and the Wassermann Laboratory at Boston: —

Antitoxin and Vaccine Laboratory.

	1918.	1917.
Vaccine virus, doses,	217,650	180,521
Typhoid prophylactic, doses,	24,578	71,893
Paratyphoid vaccine, doses,	1,950	2,723
Typhoid-paratyphoid vaccine, doses,	25,263	16,143
Diphtheria antitoxin, doses,	183,039	218,604
Anti-meningitis serum, bottles,	4,558	2,005
Anti-pneumococcus serum: —		
Type I, bottles,	357	60
Type II, bottles,	295	97
Schick outfits, bottles,	9,450	3,100
Toxin-antitoxin mixture, doses,	476	-

Wassermann Laboratory.

	1918.	1917.
Wassermann tests,	27,534	28,524
Complement fixation tests for glanders,	646	1,330
Agglutination tests for glanders,	215	423
Diagnostic examinations for rabies,	61	67
Miscellaneous, pathological and bacteriological examinations,	45	3

Institutions and Physicians served and the Number of Specimens for Wassermann Test from these Sources.

	Number of Institutions and Physicians served.				Number of Specimens.			
	1914-15 (6 Months).	1915-16	1916-17	1917-18	1914-15 (6 Months).	1915-16	1916-17	1917-18
Institutions,	42	74	89	91	6,350	23,101	24,735	23,008
Physicians,	110	514	764	985	142	2,396	3,789	4,526
Total,	-	-	-	-	6,492	25,497	28,524	27,534

Diagnostic Examinations for the Department of Animal Industry.

	1915-16 (8 Months).	1916-17 (12 Months).	1917-18 (12 Months).
Complement fixation tests for glanders,	985	1,330	646
Agglutination tests for glanders,	-	423	215
Diagnostic examinations for rabies,	47	67	61
Miscellaneous, pathologic and bacteriologic examinations,	10	3	45
Total,	1,042	1,823	967

Diphtheria antitoxin was produced at 6.5 cents per 1000 units; anti-meningitis serum, 50.5 cents per 15 cubic centimeters; pneumococcus serum, $4.10 per 100 cubic centimeters; diphtheria toxin for Schick test, 8.3 cents per .01 cubic centimeter; toxin-antitoxin mixture, 14.4 cents per cubic centimeter (one dose); vaccine virus, 4.2 cents per one-sixtieth cubic centimeter; typhoid prophylactic, 5.6 cents per cubic centimeter; and typhoid and paratyphoid vaccines, 5.6 cents per cubic centimeter. The cost of making one Wassermann test is 21.5 cents. These prices are approximate, and include all overhead expenses.

The amount of anti-pneumococcus serum has been very materially increased. We continue to make both Type I and Type II, as each of these has a specific curative value. Clinical results received from some of the hospitals on the efficacy of anti-pneumococcus serum were incomplete, and because of this lack of information special efforts were made to establish the value of the Type II serum. Dr. R. Kohn, at that time assistant director, therefore concentrated his attention on the Type II serum treatment for pneumonia. He personally supervised the treatment of 25 cases in various hospitals, with 2 deaths, — a mortality of 8 per cent. The number of cases are too few to draw definite conclusions, but the results are encouraging. Laboratory tests show that our Type II serum has a high protective value against the Type II infection in mice, and its therapeutic use in man seems to be of value. The doses of Type II anti-pneumococcus serum have been about the same as those for Type I serum, namely, a large initial dose of 200 cubic centimeters or more, followed by smaller amounts as required.

The Division has again co-operated with the Bureau of Animal Industry in making diagnostic tests for glanders, rabies and other infections of animals.

The Division has assisted both the army and navy in different ways; thus 3,406 naval aviators were tested by the Wassermann reaction. We also furnished to some of the army and navy establishments in Massachusetts quantities of diphtheria antitoxin, anti-meningitis serum, vaccine virus and other products to meet special needs.

Perhaps the most important special activity of the Wassermann Laboratory has been in connection with the standardization of the Wassermann technique. Representatives from eleven of the largest laboratories in the State were called together by the Commissioner of Health. The technique used at the Wassermann Laboratory was adopted as a standard method of procedure for all laboratories performing this test throughout the Commonwealth. The Wassermann Laboratory has also been able to aid in the State venereal program in various ways.

The work of the Division has been increased, the number of its products multiplied, and the quality of its service improved.

DIVISION OF HYGIENE.

MERRILL E. CHAMPION, M.D., *Director*.

REPORT OF DIVISION OF HYGIENE.

CHANGES IN PERSONNEL.

There have been no additions to the personnel of this Division during the past year. There have been, however, several changes. In May Miss Irene K. Griffin, who had served as a health instructor since February, 1917, resigned to be married.

June 1 Dr. Lyman Asa Jones was succeeded by Dr. Merrill E. Champion as director of the Division.

September 1 Miss Blanche Wildes, who had been loaned to the Child Conservation Committee, returned to regular duty with the Division.

In October Mrs. Ermyn Schell, who had served with us as clerk since February, 1918, resigned.

CHILD CONSERVATION WORK.

For various reasons, referable chiefly to war conditions and to lack of money for salaries, there have been no radical departures from the lines of work pursued or inaugurated last year.

The largest piece of work undertaken during the latter part of 1917, and carried on in at least one of its phases practically to completion in 1918, has been that represented by the activities of the child conservation committee. It will be recalled that this committee was appointed by Dr. Allan J. McLaughlin while Commissioner of Health, and was composed of Department members and child welfare experts from outside the Department. The first job undertaken by this committee was to survey the State with a view to determining the available resources in each city and town for the conservation of the health of the child. This survey, made by eight nurses, — one for each health district, — has been largely completed, 92 per cent of the population of the State having been reached. The year's report in full has been published in our monthly bulletin, "The Commonhealth," in a special child conservation number, dated September–October, 1918.

The results obtained cannot, of course, be credited to any one body of workers. The impetus to a large extent came from both Federal and State agencies, and was passed on to the local agencies in the dif-

ferent cities and towns. The seed carefully and patiently sown in the past by health officers, nurses and private workers was forced into an earlier and more abundant growth under the stimulus of the "children's year." The State Department of Health, especially through its Child Conservation Committee, may rightfully claim its due share in these results, and does not wish to claim more.

In addition to the work carried on in direct co-operation with the child conservation committee, the Division of Hygiene has continued various lines of work started previously to the present year. The policy has been continued of holding "health weeks" in various parts of the State. Our exhibit has been used at such times, in charge of one or two nurses who have given talks on health subjects, and demonstrations, more particularly for mothers and older girls, on the best method of washing, dressing and caring for the baby. Such health days or weeks were conducted during the year in —

Brookfield.
Fisherville.
Grafton.
Harwich.
Hudson.
Hyannis.
Lynn.
Marion.
Marlborough.
Millbury.
Monson.
North Brookfield.
Orleans.
Palmer.
Thorndike.
Three Rivers.
Provincetown.
Upton.
Ware.
Wareham.
Warren.
West Warren.
Yarmouth.

Similar exhibits, lectures and demonstrations were provided also at the agricultural fairs in the following towns: Marshfield, Barnstable, Weymouth and Sturbridge.

Lecture Service.

The lecture service of the Department has been continued. Various members of the Department have participated in this, though the child conservation nurses have done the major part of it. Owing to the tremendous absorption of the public in problems of food and fuel during the war, lectures on health had to take second place, in spite of the greatly increased need for the dissemination of health information. Moreover, during the summer a great deal of emphasis was laid by the Department on venereal disease propaganda. Furthermore, during the

influenza epidemic public meetings were undesirable, and acute disease, only, occupied, of necessity, the center of the stage. Since the two plagues, war and influenza, have ceased, a greater demand is shown for discussions of general public health matters. The following tables will give an idea of the lecture service for the year 1917–18.

Lectures were given during the year on the following subjects: —

Child hygiene,	384
Venereal diseases,	108
Foods and food inspection,	45
Public health,	21
Public health nursing,	18
Rural sanitation,	1
School hygiene,	7
Communicable diseases,	4
Wear and tear diseases of adult life,	2
Influenza,	4
Oral hygiene,	1
Quackery and patent medicines,	1
Tuberculosis,	1
	597

The above lectures were given by months, as follows: —

Month.	Lectures.	Number Present.
1917.		
December,	37	3,550
1918.		
January,	37	3,306
February,	107	13,397
March,	62	6,969
April,	87	12,142
May,	101	8,838
June,	47	6,420
July,	26	3,113
August,	41	21,843
September,	16	7,837
October,	4	1,410
November,	32	11,996
Total,	597	100,821

During the fiscal year ending Nov. 30, 1918, lectures were given in the following cities and towns: —

Adams,	2	Fall River,	8
Agawam,	1	Falmouth,	1
Amherst,	2	Fitchburg,	9
Andover,	1	Framingham,	1
Arlington,	2	Franklin,	2
Ashburnham,	2	Gardner,	3
Ashfield,	3	Georgetown,	1
Ashland,	1	Gloucester,	3
Athol,	15	Goshen,	1
Attleboro,	1	Grafton,	14
Auburn,	2	Great Barrington,	2
Ayer,	1	Greenfield,	5
Barnstable,	19	Harvard,	1
Barre,	3	Harwich,	10
Bedford,	1	Hatfield,	1
Belmont,	2	Haverhill,	3
Bernardston,	1	Hingham,	3
Beverly,	2	Holden,	1
Blackstone,	1	Holliston,	1
Boston,	66	Holyoke,	5
Bourne,	8	Hopkinton,	1
Boxford,	1	Hudson,	5
Brewster,	2	Hull,	1
Brockton,	4	Lancaster,	1
Brookfield,	3	Lanesborough,	1
Brookline,	4	Lawrence,	3
Buckland,	1	Lee,	4
Cambridge,	25	Leicester,	1
Chatham,	6	Lenox,	1
Chelsea,	3	Leominster,	4
Chicopee,	2	Lexington,	2
Clinton,	4	Lowell,	11
Cohasset,	1	Lynn,	10
Cummington,	3	Malden,	4
Dalton,	3	Manchester,	1
Danvers,	1	Mansfield,	2
Dartmouth,	12	Marblehead,	1
Deerfield,	2	Marion,	7
Dennis,	6	Marlborough,	5
Dighton,	1	Marshfield,	2
Eastham,	1	Mashpee,	1
Easthampton,	1	Mattapoisett,	7
Easton,	1	Medford,	1
Everett,	1	Medway,	2

Melrose,	1	Somerville,	1
Mendon,	1	Southampton,	1
Methuen,	1	Southborough,	1
Middleborough,	2	Southbridge,	1
Milford,	3	Springfield,	6
Millbury,	6	Stockbridge,	1
Millis,	1	Stoneham,	2
Millville,	1	Stoughton,	1
Milton,	2	Sunderland,	2
Monson,	4	Sutton,	1
Natick,	1	Taunton,	3
Needham,	2	Templeton,	1
New Bedford,	4	Truro,	4
Newburyport,	1	Upton,	4
Newton,	2	Uxbridge,	1
North Adams,	5	Wakefield,	3
North Brookfield,	7	Waltham,	2
Northampton,	2	Ware,	3
Northbridge,	1	Wareham,	6
Norwell,	1	Warren,	5
Orange,	1	Watertown,	3
Orleans,	4	Webster,	3
Oxford,	1	Wellesley,	3
Palmer,	11	Wellfleet,	2
Peabody,	4	West Brookfield,	2
Pepperell,	2	Westborough,	1
Petersham,	1	Westminster,	1
Pittsfield,	10	Weymouth,	1
Plainfield,	3	Wilmington,	1
Provincetown,	3	Winchendon,	1
Quincy,	9	Winchester,	2
Randolph,	1	Winthrop,	2
Reading,	4	Worcester,	9
Revere,	2	Yarmouth,	8
Rockland,	4		
Salem,	2	Total,	593
Salisbury,	1		
Sandwich,	9	Concord, N. H.,	1
Saugus,	1	Manchester, N. H.,	1
Shelburne,	1	Nashua, N H.,	1
Sherborn,	3	New York City,	1
Shirley,	2		
Shrewsbury,	1	Total,	4

Stereopticon Slides and Moving Pictures.

Various additions have been made from time to time to our series of stereopticon slides. An automatic stereopticon lantern, the stereomotorgraph, was experimented with; this has not proved entirely satisfactory so far. An attempt is being made to secure a good portable moving-picture machine which can be used in any hall without conflicting with the fire prevention laws of the State.

Educational Material.

Various educational leaflets were published during the year. A series of articles on food, written by Mrs. Alzira W. Sandwall, for the monthly bulletin, was distributed as pamphlets. A set of "Food Rules for School Children" was prepared; these have met with a ready response. An excellent booklet on "The Care of the Child in Hot Weather," written for the Department by Dr. Richard M. Smith, was found most useful.

The most ambitious piece of work for the year, however, was the "Outline for a Course in Child Welfare," prepared for the use of vocational schools in particular, though suitable for use in any school. The State Board of Education co-operated with the State Department of Health in this matter, as did the Woman's Section of the Council of National Defense. I believe that this will be the beginning of a great advance in child conservation, for by this means a large body of women and girls will be taught the scientific basis of child welfare.

Monthly Bulletin.

Beginning with the July number the monthly bulletin was issued in revised form under the title of "The Commonhealth." A double number, dealing with child conservation and containing a report of last year's work, was published in October.

Publicity.

During part of the year, through the courtesy of the Massachusetts Health Committee, we have had the benefit of the assistance of an expert publicity engineer, Prof. Charles E. Bellatty of Boston University. He has aided us in getting our message across to the public.

Infantile Paralysis After-care.

The Infantile Paralysis Commission of Harvard University has continued its co-operation with us during the past year, entirely without financial obligation on our part.

Food in its Relationship to Health.

One phase of the work of this Division which represents an incursion into a somewhat new field is that of food in its relationship to health. This branch has been in charge of Mrs. Alzira Wentworth Sandwall, who has made of it a definite entity. Original stereopticon slides and poster exhibits have been prepared and found most useful. Helpful relationships have been formed with agencies doing similar work.

During the summer, through the courtesy of Miss Agnes Donham of the Garland School for Homemaking, this Division was privileged to maintain a health exhibit on the food trolley which traversed the eastern part of the State.

Contact with New Agencies.

It has been the constant aim of the director to reach new agencies which can aid in furthering the health work of the State. The new contact through the vocational schools has already been referred to. We are now working in close co-operation with the home demonstration agents in charge of the agriculture and home economics activities of the State. Especial mention should be made of the valuable assistance of the various local child conservation committees of the Women's Section of the Council of National Defense. Still closer relationship will be sought with all these agencies and with the granges and parent-teacher associations.

Investigations in Other Communities.

During the current year a visit was made by the present director of the Division to Toronto to study the nursing system there, and more especially to investigate the Toronto method of handling school hygiene.

New Lines of Activity suggested.

Extension of Cancer Work.

During the year 1917–18 the State Department of Health has had the benefit of the service furnished by the Cancer Commission of Harvard University. Pathological specimens sent in by hospitals and physicians have been examined free of charge by an expert pathologist. The service has cost the Commission about $4,000, but the expense to the State Department of Health has been only that of furnishing the containers for the specimens, at a cost of approximately $50. The value of this service has been twofold. First, expert service, ordinarily very expensive, has been furnished to physicians and hospitals free,

thus rendering an accurate diagnosis available to all. Second, the service has been of very great educational value in that it emphasized the vital need of early, accurate diagnosis and surgical treatment.

The coming year, the Department should assume the greater part of this expense.

Medical Social Service.

It has long been recognized that there are two classes of persons needing assistance. One of these classes is made up of paupers, properly so called, — persons who are chronically unable to handle, unaided, their own affairs. The other class, one which is infinitely more promising than the first, is composed of persons who, because of temporary ill health, or because of a certain degree of permanent physical impairment, are for the time being unable to control their environment. These persons, if neglected, tend to drift into the pauper class. If, on the other hand, they receive just the right lift at the right time, they may be returned to the class of those entirely self-supporting.

It is the duty of medical social service to rehabilitate the last-mentioned class of persons. Is it the duty of the State to oversee and co-ordinate such effort? As a result of the work done in following up those in difficulties because of the recent influenza epidemic, it is the firm conviction of many interested and experienced individuals that such a function does properly belong to the State in general, and to the State Department of Health in particular. It would seem a reasonable and sane step to take to request the Legislature for an appropriation to enable the Department of Health to study thoroughly this subject in all its aspects.

Day Nurseries.

As a result of the entry of women into industry a genuine problem in child conservation is presented by the growth of the day nursery. Many arguments may be addressed on both sides of the question as to the desirability of day nurseries. It would seem reasonable that every effort should be made, through the liberal use of mothers' aid pensions and other agencies, to keep the mother of small children at home. On the other hand, certain women are obliged to work or will work and, as a result, something must be done to care for their children. There is a strong movement on foot to ask for legislation looking to the regulation of day nurseries in order to safeguard the children cared for in them. It is the belief of many that such regulation should be in the hands of the State Department of Health.

School Hygiene.

One of the most pressing problems brought to the front as a result of the war has been the prevention and correction of physical defects in children. Various estimates have been made, but conservative figures for the draft would lead us to believe that 25 per cent of the rejections were due to defects which might have been prevented or remedied during the early years of life.

Massachusetts has had for eleven years a school inspection law under the provisions of which every city and town in the Commonwealth must have one or more school physicians. It is easily seen, however, from the investigation made two years ago by this Department, that there is no co-ordination in medical school inspection in this State, and furthermore, that much of it is nominal only. A weak point in the law is the absence of any provision making compulsory the employment of school nurses.

The remedy for this state of affairs would seem to be a co-ordination and standardization of effort through the enforcement of rules and regulations made by a central body like the State Board of Education or the State Department of Health. It makes little difference which of these two departments is actually in direct charge of the work; both are equally concerned, and regulations should be drawn up only after careful consideration on the part of the two departments.

A further important factor in the school hygiene problem is the teaching of hygiene. Modern scientific instruction in this most indispensable subject under competent teachers should be required in all schools, including the normal schools. Some effort should be made this year looking toward adequate legislation on the subject of school hygiene.

Report of the Board of State Examiners of Plumbers.

James C. Coffey, *Chairman.*

Report of the State Examiners of Plumbers.

Information concerning Examinations for Plumbers, showing the Place and Date of Examination and Number examined, together with the Results of the Examination, etc.

Examinations.	Examined.	Passed.	Refused.
Boston, Dec. 1, 1917,	57	17	40
Lowell, Dec. 15, 1917,	17	3	14
Boston, Jan. 5, 1918,	42	14	28
Pittsfield, Jan. 19, 1918,	11	5	6
Boston, Feb. 2, 1918,	44	14	30
Springfield, Feb. 16, 1918,	22	8	14
Boston, March 2, 1918,	65	19	46
Fall River, March 16, 1918,	21	5	16
Boston, April 6, 1918,	71	19	52
Worcester, April 20, 1918,	29	4	25
Boston, May 4, 1918,	42	8	34
Lowell, May 18, 1918,	17	5	12
Boston, June 1, 1918,	57	16	41
Pittsfield, June 15, 1918,	5	1	4
Boston, July 6, 1918,	59	19	40
Boston, Sept. 7, 1918,	44	9	35
Springfield, Sept. 21, 1918,	13	4	9
Fall River, Oct. 26, 1918,	9	2	7
Boston, Nov. 2, 1918,	45	13	32
Worcester, Nov. 16, 1918,	10	1	9
Totals,	780	186	494

	Masters.	Journeymen.	Total.
Licenses granted on account of examination Dec. 1, 1917, to Dec. 1, 1918.	54	130	184
Probationary licenses issued during the year,	-	7	-

Registrations.	Masters.	Journeymen.
December, 1917,	3	17
January, 1918,	7	13
February, 1918,	5	13
March, 1918,	8	19
April, 1918,	1	8
May, 1918,	5	17
June, 1918,	9	19
July, 1918,	5	17
August, 1918,	5	1
September, 1918,	3	8
October, 1918,	4	9
November, 1918,	6	9
Totals,	61	150

Meetings,	63	Examinations,	20

Fees received.	Paid to the Treasurer of the Commonwealth.
680 examination fees, at $0.50,	$340 00
61 master plumber licenses issued, at $2,	122 00
148 journeyman plumber licenses issued, at $0.50,	74 00
1,692 master plumber renewals issued, at $0.50,	846 00
3,912 journeyman plumber renewals issued, at $0.50,	1,956 00
123 back fees, at $0.50,	61 50
Total,	$3,399 50

For carrying out the Provisions of the Act relative to the Examination of Plumbers.

Salary of secretary,	$2,000 00
Examiner's wages,	565 00
Traveling,	551 00
Express,	29 14
Printing,	158 32
Postage,	195 02
Books, stationery and supplies for typewriter,	18 31
Plumbers' materials,	4 00
Extra services,	940 00
Cleaning,	25 00
Office supplies,	1 00
Telephone and lighting,	91 44
Miscellaneous,	6 75
Total,	$4,585 84
Unexpended balance,	214 16
	$4,800 00

Summary of Registrations.

	Masters.	Journeymen.
Certificate holders,	469	490
Licenses, year ending May 1, 1918,	1,836	4,260
Totals,	2,305	4,750

Deceased Plumbers (reported to Examiners).

Masters,	6	Journeymen,	5

Respectfully submitted,

JAMES C. COFFEY.
CHARLES R. FELTON.
DAVID CRAIG, *Clerk.*

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Public Document No. 56

TWENTY-FIFTH ANNUAL REPORT

OF THE

BOARD OF REGISTRATION IN MEDICINE

For the Year ending December 31, 1918

BOSTON
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1919

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approved by the
Supervisor of Administration.

The Commonwealth of Massachusetts.

BOARD OF REGISTRATION IN MEDICINE,
STATE HOUSE, Dec. 31, 1918.

To His Excellency SAMUEL W. MCCALL, *Governor*.

SIR: — The Board of Registration in Medicine respectfully submits the following as its annual report for the year ending Dec. 31, 1918.

FINANCIAL STATEMENT FOR FISCAL YEAR.

Appropriations.

Salaries of members of Board,	$4,300 00	
Salary of executive clerk,	1,250 00	
Extra (emergency) clerical services,	50 00	
		$5,600 00
Incidental expenses of Board and department,		3,100 00
		$8,700 00

Expenditures.

Salaries of members of Board,	$4,300 00	
Salary of executive clerk,	1,250 00	
Extra (emergency) clerical services,	15 00	
		$5,565 00
Incidental expenses of Board and department,		2,378 60
		$7,943 60

Receipts.

151 examination fees, at $25 each,	$3,775 00	
138 examination fees, at $20 each,	2,760 00	
15 re-examination fees, at $3 each,	45 00	
Fees received for certified statements,	587 15	
Interest on deposits in Merchants National Bank, paid into the treasury of the Commonwealth,	5 81	
		$7,172 96

Since the establishment of the Board in 1894, the fees received from applicants for registration, and paid into the treasury of the Commonwealth, amount to $155,917.57. The expenditures of the Board amount to $153,801.95. In dollars and cents, therefore, the Commonwealth has received $2,115.62 in excess of the total amount expended.

For the year ending Nov. 30, 1919, the Board recommends an appropriation of $4,300 for salaries of Board, $1,400 for salary of clerk, $20 for extra (emergency) clerical service, $250 for emergency stenographers to report important hearings, and $2,394.50 for incidental expenses of Board and department.

The number of persons applying for registration for the first time this year is 289, all of whom have been examined except 7. In addition there were 35 who had failed in previous examinations, making the total number of applicants examined 327, as shown in the following table, together with the percentages acquired: —

Applicants.	Examined.	Registered.	Rejected.	Percentage rejected.
February examination, for war service, .	68	68	-	-
March examination, ...	63	49	14	22
May examination, ...	53	41	12	22
July examination, ...	56	39	17	30
September examination, ...	29	20	9	31
November examination, ...	32	22	10	31
Additional special examinations for war service.	26	26	-	-
	327	265	62	18+

The following tabulation is based upon the results in the first examination of applicants during the year covered by this report: —

Medical Institutions granting the Degree.	Number examined.	Number registered.	Year of Graduation of Rejected Applicants.
Harvard,	96	96	
Tufts,	63	60	1918-18-18.
Massachusetts College of Osteopathy,	36	21	1909-12-15-15-15-16-16-17-17-18-18-18-18-18-18.
Boston University School of Medicine,	16	16	
Physicians and Surgeons, Boston,	8	1	1914-14-15-15-16-16-17.
Johns Hopkins,	5	5	
American School of Osteopathy,	5	2	1917-17-18.
Middlesex College of Medicine and Surgery,	4	2	1918-18.
Chicago Hospital College of Medicine,	4	3	1918.
University of Michigan,	3	3	
Rush Medical College,	3	3	
Maryland Medical College,	2	2	
Baltimore Medical College,	2	1	1905.
Medical School of Maine,	2	2	
University of Pennsylvania,	2	2	
Philadelphia College of Osteopathy,	2	1	1915.
University of Georgetown,	2	2	
University of Vermont,	2	2	
Meharry Medical College,	2	1	1915.
Physicians and Surgeons of Columbia College.	2	2	
Stanford University,	1	1	
Los Angeles College of Osteopathy,	1	1	
Physicians and Surgeons of Southern California.	1	1	
Des Moines Osteopathic School,	1	1	
Maryland College of Medicine and Surgery,	1	-	1914.
University of Maryland,	1	-	1916.
Physicians and Surgeons, Baltimore,	1	-	1902.
Howard University,	1	1	
Columbian University,	1	1	
Bellevue Hospital Medical College,	1	1	
New York University and Bellevue Medical College.	1	1	
Long Island College Hospital,	1	1	
Cornell University Medical College,	1	1	
Syracuse University College of Medicine,	1	1	
Medical College of Virginia,	1	1	

Medical Institutions granting the Degree.	Number examined.	Number registered.	Year of Graduation of Rejected Applicants.
Wisconsin College of Medicine and Surgery,	1	1	
McGill, ...	1	1	
Laval, ...	1	-	1917.
Foreign, ...	1	-	1903.
Detroit College of Medicine and Surgery, .	1	1	
Washington University Medical School, St. Louis.	1	1	
University of West Tennessee, ...	1	-	1915.
Hahnemann Medical College, Pennsylvania.	1	1	
Temple University, ...	1	1	
Woman's Medical College of Pennsylvania,	1	1	
Jefferson Medical College, ...	1	1	
Yale Medical School, ...	1	1	
Eclectic Medical College, Cincinnati, .	1	1	
Ohio State University College of Homœopathic Medicine.	1	1	
American Medical Missionary College, .	1	1	
Hahnemann Medical College and Hospital, Chicago.	1	1	
University of Oklahoma School of Medicine,	1	1	
State University, Colorado, ...	1	1	

Tabulations showing number of first examinations and average ratings of applicants from medical schools represented by not less than 3 applicants: —

Medical Institutions.	Number examined.	Average Ratings.
Harvard, ...	96	80.4
Tufts, ...	63	78.6
Massachusetts College of Osteopathy, ...	36	73.5
Boston University School of Medicine, ...	16	78.7
Physicians and Surgeons, Boston, ...	8	69.9
Johns Hopkins, ...	5	82.4
American School of Osteopathy, ...	5	71.9
Middlesex College of Medicine and Surgery, ...	4	70.7
Chicago Hospital College of Medicine, ...	4	76.0
University of Michigan, ...	3	78.4
Rush Medical College, ...	3	80.4

The following tabulation is published to illustrate the point which has been made that students frequently find it necessary to take supplementary instructions before being able to pass the examinations of this Board, for it is reported by some of these students that when they find themselves inadequately equipped, it is a common practice to hire instructors to give them courses in such subjects in which they find themselves deficient.

Name of Institutions.	Number rejected.	Times rejected.	Registered on —
Massachusetts College of Osteopathy,	2	3	
Massachusetts College of Osteopathy,	3	2	Third examination.
Massachusetts College of Osteopathy,	3	2	
Massachusetts College of Osteopathy,	4	1	Second examination.
Massachusetts College of Osteopathy,	3	1	
College of Physicians and Surgeons, Boston,	2	3	
College of Physicians and Surgeons, Boston,	2	2	
College of Physicians and Surgeons, Boston,	1	1	Second examination.
Tufts,	1	2	Third examination.
Tufts,	1	1	Second examination.
Tufts,	1	-	
Middlesex College of Medicine and Surgery,	1	3	
Middlesex College of Medicine and Surgery,	1	1	
American School of Osteopathy,	1	3	Fourth examination.
American School of Osteopathy,	1	3	
Meharry Medical College,	1	1	Second examination.
Physicians and Surgeons, Baltimore,	1	1	Second examination.
Maryland College of Medicine and Surgery,	1	1	
University of Maryland,	1	1	
Baltimore Medical,	1	1	
Philadelphia College of Osteopathy,	1	1	Second examination.
University of Berlin,	1	1	
University of Laval,	1	2	
Chicago Hospital College of Medicine,	1	1	
University of West Tennessee,	1	2	Third examination.

Applications for registration must be made upon blanks furnished by the Board, and must be accompanied by a certified photograph of the applicant, and filed with the required fee not later than five days before the date of the examination.

On receipt of an application properly executed, a ticket of admission is issued to the applicant, showing his application number and the date and place of the examination. No one is admitted except by ticket bearing date and place of examination. Tickets are issued to rejected applicants entitled to a re-examination, upon payment of a fee of $3, when applied for not later than Thursday of the week next preceding date of an examination.

Three examinations yearly are provided by law, beginning, respectively, on the second Tuesday in March, July and November. Extra meetings for conducting examinations have been held beginning on the second Tuesday in February, May and September, and special examinations as explained later in the report.

The examinations are conducted in the English language only, and are intended to cover substantially the instruction given in the high-grade medical schools in this country. The subjects on which the examinations are principally conducted are anatomy and histology, physiology and hygiene, pathology and bacteriology, surgery, obstetrics and gynecology, diagnosis and therapeutics, pediatrics and toxicology.

Subsequent to an examination, the Board devotes a sufficient number of days to a consideration of the work done by each applicant, and in doubtful cases carefully reviews all the papers and other evidence submitted.

The law requires that the "examinations shall be wholly or in part in writing in the English language." It should be noted that this requirement does not preclude oral examinations in part, nor in part practical work in the laboratory, or other demonstrations of a practical character.

This Board is constantly trying to avoid making its examinations technical except so far as anatomy, pathology, and, occasionally, questions in chemistry are employed, but questions on these subjects are such as every practitioner should be able to answer because they are fundamental or are subdivisions of, or closely related to, the common problems of the practice of medicine. To this end the co-operation of the medical schools has been secured, and a part of each regular examination has been held in some one of the medical schools in this city, which have been visited in rotation. The Board

wishes to express its grateful appreciation of the courtesies extended by these institutions.

The examinations conducted by the Board are not severe, nor is the rating of the work submitted overcritical, so whenever it appears that any considerable proportion of graduates of any school fail to secure approval, such showing strongly indicates deficiency either in the candidate or in the curriculum of the institution from which he came. This Commonwealth has not adopted the policy of declining to accept applications from all poorly equipped medical schools, and, consequently, in a negative way, encourages the continuation of such institutions. This is to a certain extent an injustice, since it indirectly leads to the selection of such schools by some young people who are led to believe that an acceptable medical equipment will be secured, but later find that the time spent has been wasted. Thirty-nine States in this Union are carefully protecting those desiring to study medicine by discrediting certain low-grade schools.

The Legislature of 1918 enacted amendments to the medical registration law under chapters 85 and 217 of the General Acts. These amendments provide that the examination fee to be filed with an application shall be $25, and for each re-examination, allowed under the application, a fee of $3; also that a fee shall be paid for certified statements of registration, the amount of the fee being from $1 to $2, according to the form of certificate required, and $5 for a duplicate copy of certificate of registration.

It has become more generally known that the disciplinary powers of this Board have been amplified under laws enacted in recent years. This knowledge has led to the filing of complaints alleging irregularities of professional conduct ranging from inefficiency to criminal practice.

Whenever it has appeared that complaints were due to imperfect understanding of the duties and privileges of physicians, or were prompted by prejudice, every effort has been made by the Board to act as mediator, or by advice to correct wrong impressions, for it should be recognized that the disappointments incident to disease should not be the foundation for unwarranted attacks upon a practitioner. But whenever it has been shown that there was reasonable ground to believe that a physician had been guilty of an unprofessional or crim-

LIST OF NURSES REGISTERED IN 1918.

Adams, Ada Gordon.
Albertson, Phyllis.
Alexander, Esther Mersereau.
Allison, Harriet Georgianna.
Almond, Lucille Germaine.
Alward, Grace Wheeler.[1]
Anderson, Anna Isabelle.
Anderson, Elizabeth Millar.
Anderson, Lulu Grace.
Anderson, Marie Elizabeth.
Armstrong, Clara Belle.
Armstrong, Katherine Elizabeth.
Ashman, Lucy.
Averill, Helen.
Avery, Emily Blanche.

Babin, Anna Catherine.
Baker, Anna.
Baker, Attie Dimmis.
Baker, Jean Eliza.
Baldwin, Lina Ransom.
Baldwin, Vera Camille.
Ballentyne, Frances Mary.
Barlow, Edith Raymond.
Barnard, Edith Johnson.
Barnes, Frances Lauretta.
Barr, Elizabeth Williamson.
Barrett, Elizabeth Veronica.
Barrett, Helena Agusta.
Barron, Elizabeth A.
Barron, Margaret Adelaide.
Barry, Theresa Mary.
Bassett, Margaret.[1]
Bates, Caroline Cornelia.[1]
Bayne, Mary Ellen.
Beaton, Greta Mae.
Beaudreault, Bernadette.
Beaudreault, Marie Louise.
Beaudreault, Sophie Gertrude.
Beaudry, Blanche Yvonne.
Beedles, Elizabeth May.
Behie, Alice Nettie.
Belden, Katharine Parsons.
Bell, Adelaide Lancaster.[1]
Bentley, Anna.
Bergendahl, Helen Cornelia.
Bergquist, Signe Maria.
Berry, Florence Lydia.
Beslove, Anita Maugerite.
Bethel, Elizabeth Winifred.
Beynon, Eva Hazzard.
Bicks, Dorothea Sophie Caroline.
Billings, Alice Marguerite.
Blackburn, Violetta.
Blair, Charlotte Jane.
Blakeley, Marion.
Bleakney, Jessie Rebecca.
Blech, Jeanette.
Blomberg, Eva Bernhardina.
Bodkin, Sarah Jane.
Bogrett, Mary Louise.
Bonney, Viola May.
Bousquet, Agnes Mary.
Bowen, Lily.
Bowker, Pearl May.
Bowman, Minnie Rebecca.
Bowne, Mildred May.
Bowser, Louise Avery.
Boyce, Edna Marie.
Boyd, Gladys Marion.
Boyd, Hattie Elizabeth.
Boyd, Ruth Constance.
Boyden, Grace Amelia.
Boynton, Sara Evelyn.

[1] With honor.

Bracewell, Henry Francis.[2]
Bradford, Velma Katherine.
Brady, Ellen.
Bragdon, Hazel Bailey.
Brannen, Annis.
Bray, Beulah Frances.
Bremer, Henriette Sophie.
Brennan, Mary Teresa.
Brennan, Rose Virginia.
Brett, Hattie Marion.
Brewster, Dorothy Elizabeth.
Brightman, Alice May.
Brightman, Ariel Beatrice.
Brindley, Barbara Ellen.
Britten, Alice Stanton.
Brook, Mary.
Brooks, Emma Marion.
Brooks, Vera Hazel.
Brosnahan, Margaret.
Brown, Florence M.
Brown, Jeanie Stewart.
Brown, Sara Davis.
Buckley, Eva Constance.
Buckley, Marguerite.
Buford, Louise.[1]
Bullard, Winnifred Arvilla.
Bullock, Bertha Maud.
Bullock, Elizabeth Frieda.[1]
Bulman, Edith Mary.
Buol, Kate Anna.
Burbank, Mary Irene.
Burdick, Elsie Trask.
Burgett, Mae.
Burke, Katherine Frances.
Burke, Mary Cecelia.
Burrow, Grace Ann.
Burton, Edith Pearl.
Butland, Etta Levenia.
Butler, Gertrude Mary.

Cabot, Marjory.[1]
Cahill, Mary Agnes.
Cahill, Mary Catherine.
Cameron, Annie Mabon.
Campbell, Blanche Eleanor.
Campbell, Clara Louise.
Campbell, Mary Anita.
Campbell, Mary Margaret.
Canning, Rebecca Jane.
Carey, Katharine Louise.
Carey, Margaret Celia.
Carey, Margaret Cotter.
Carlson, Emily Leontina.
Carr, Bessie Mary.
Carr, Katherine.
Carroll, Kathryn Valerian.
Carter, Erma Irene.
Carty, Beatrice Bertha.
Case, Elizabeth Seabury.
Cass, Annie Lee.
Cassidy, Margaret Teresa.
Cathcart, Margaret.
Caulfield, Margaret Anna.
Cavanaugh, Alice Xavier.
Chadwick, Mary Eliza.[1]
Chambers, Rachel.
Champion, Ethel Andrews.
Chatterton, Alice.
Cherry, Ethel Brown.
Christiansen, Ellen.
Church, Jessie Pearle.
Churchill, Alice Symonds.
Chute, Zephima Blanche.
Clark, Amy Mary.
Clark, Eva Lillian.
Clark, Margaret.[1]
Clark, Nettie Estelle.
Cleveland, Gertrude Dexter.
Clifford, Ione Constance Mary.
Clifford, Mary Morton.
Clinch, Amy Frances.
Clogston, Jessie Irene.
Colton, Dorothea.[2]
Compton, Emeline Frances.
Conlin, Katherine Frances.
Conrad, Florence Jean.
Constantine, Mildred.[1]
Cook, Mary Teresa.
Cooke, Alma Bertha.
Coombs, Mary Elizabeth.

[1] With honor. [2] Nongraduate.

tabulation at the meetings in Boston. This shows that the service rendered by the six members of the Board conducting practice at home is largely an unpaid contribution to the State, for any physician in active practice would necessarily sustain a considerable loss in income while spending this amount of time away.

It seemed to be difficult for the Army and Navy to secure the required number of physicians, for insistent appeals were made from time to time for more men to apply for commissions. It was felt by this Board that every effort should be made in this emergency, and no person eligible for consideration by the government was kept waiting. These frequent emergency examinations were conducted in the office of the Board by the secretary, assisted by such members as might be able to attend. The written work was forwarded to the absent members, and the final returns tabulated. The Board felt that under war conditions the needs of the government should receive first consideration, and no applicant was rejected who appeared to be sufficiently well qualified to fill acceptably government positions. Medical schools were making every effort to shorten courses by doing away with vacation periods, and, while covering the usual field of study, graduating students in the shortest possible time. The Board has been convinced that the course adopted was for the best interests of the country.

The statistics show that a larger percentage of applicants have secured registration than in former years, but the conditions made it absolutely necessary to avoid the possibility of rejecting any useful practitioner, because even though all might not be accepted or needed for war work, all available medical material was needed for civilian service.

The recent epidemic of influenza demonstrated the depleted medical resources of the State, for many cases of dangerous and painful illness, in addition to many major accidents, were either not cared for at all or were inadequately treated.

Many students of history affirm that war is followed by unusual disturbances of living conditions which induce sickness, and it is feared that the demand for physicians cannot be met for some time to come.

It is regrettable that the improved methods which are being developed for the better education of physicians may have to be modified for a time, but this is a part of the penalty exacted by war.

Several physicians formerly practicing in towns in Massachusetts were so impressed by government appeals that they left their homes, with the result that there is no available medical service left in these localities. Appeals are coming to this Board for doctors to fill these vacancies, and notices have been sent to recent registrants relative to these openings. The Volunteer Medical Service Corps at Washington has also been appealed to, but at the present time very little progress has been made in meeting these requests. In addition, the Board has requested His Excellency the Governor to appeal to the surgeon-general for the release of such physicians as may be spared from the service.

Responding to complaints made by students and graduates of a certain medical school in this State, this Board co-operated with the Attorney-General in presenting to the legislative committee on education facts relating to the treatment of these students, and the alleged lack of proper equipment of this institution to carry on the functions of a medical college.

The committee did not see fit to take any action at this time, and, so far as has been learned, has not made any investigation of the curriculum of the institution.

Since this Commonwealth has not adopted the practice maintained by many of the other States of providing for inspection and supervision of medical schools and colleges, this Board recommends that some responsible committee or department of the State be authorized to investigate and report upon the status of medical education in this State, and, further, be directed to make such recommendations as may be found advisable, because the alleged abuses should be either demonstrated or disproved.

At the present time one may feel reasonable doubt as to the propriety of allowing any institution, whose students or graduates in any considerable number publicly criticize the quality of the instruction given, to continue to solicit the expenditure of time and money.

The time devoted to the study of medicine should not be

wasted, for every student is entitled to all the instruction and training which are promised in the published statements of educational institutions, and if he is deceived, both he and the people whom he afterwards serves are defrauded.

Some of these students have made sacrifices to secure funds for an education and they feel that they cannot afford to lose that which has been paid and make a new start, for courses taken in a low-grade school are not accredited in the better institutions, hence the time spent may have been practically lost. This wastage, if it exists, is a reflection on the policies of a State which permits it to continue, for young people are entitled to protection against loss of time and money just as much as any citizen is protected in his property rights. In some instances, a student's time and money saved for his education are his only assets aside from the common asset of his person.

Any investigation of conditions suggested by complaints which have reached this Board could be properly conducted by the legislative committee on education or by the State Board of Education.

The Board again wishes to state its appreciation of the work done by Mr. Arthur E. Keating of the State police force, who has given much valuable assistance to the Board in making investigations and preparing cases for prosecution.

Registration of Chiropodists.

Although every possible effort has been made to notify every person who might have registered under the waiver in the law providing for the registration of the practice of chiropody, so many of these practitioners failed to take advantage of this registration without examination, the Legislature was convinced that the time for general registration should be extended, and hence chapter 15 of the General Acts of 1918 was enacted, giving all who had been in practice two years prior to the passage of the act, the privilege of registration without examination if application was made on or before May 1, 1918.

The Board has registered this year 73 applicants, 8 of whom are graduates of schools of chiropody which meet the requirements of the law at the present time. The remaining 65 comprise those granted registration under the extension of time,

those registered under re-examination, and those whose applications were filed last year but relative to which final disposition had not been made.

At the time of the passage of the law comparatively few practitioners of chiropody were graduates of recognized schools, and there were few pupils studying this branch of medicine, but now that the State is regulating this practice, more people will secure a better education and be in position to apply for registration under the requirements of the law. There will be in the future a larger number of applicants, because of educational facilities which have developed.

The law restricting chiropody to registered practitioners is now generally respected and obeyed, but at first there were representatives of firms manufacturing arch supports and other appliances who were examining and prescribing for troubles which can only be treated legally by registered practitioners. Every reported irregularity of this kind was investigated by the Board and the law explained, with the result that this practice is not carried on to any extent at the present time. It should be fully understood by dealers in footwear that only those who are properly registered by this Board may diagnose and prescribe for disabilities of the feet, and any one learning of attempts to practice illegally should report the fact to this Board.

Messrs. Harry P. Kenison and Gilbert N. Pettingill have continued to act as representatives of the chiropodists in association with Drs. S. H. Calderwood, A. L. Chase and W. P. Bowers of this Board in conducting examinations.

For conducting the work of the chiropody department for the ensuing year the Board recommends an appropriation, as follows: —

For members of the department and chiropodist assistants, $600; and for incidental expenses of the department, $487.

Financial Statement of Chiropody Department.

Appropriations.

Salaries of Board members,	$300 00
Salaries of chiropodist assistants,	300 00
Clerical services,	350 00
Incidental expenses of department,	600 00
	$1,550 00

Expenditures.

Salaries of members of department,	$300 00
Salaries of chiropodist assistants,	300 00
Emergency clerical services,	73 50
Incidental expenses of department,	290 98
	$964 48

Receipts.

55 examination fees, at $10 each,	$550 00
11 examination fees, at $15 each,	165 00
449 renewal fees, at $2 each,	898 00
3 re-examinations, at $2 each,	6 00
1 certified statement, at $1,	1 00
	$1,620 00

The Board again calls attention to the inadequate accommodations furnished by the State, for the space provided is insufficient for the transaction of its routine business, and whenever it has been necessary to conduct hearings, not only the Board but complainants, defendants, counsel and witnesses are seriously inconvenienced. It is most undignified for a State department to be obliged to transact important business under conditions which are annoying to all concerned, and it is hoped that adequate accommodations will be provided in order that methods of procedure and opportunities for judicial conclusions may be freed from the annoyance incident to overcrowding and interruption.

It is the purpose of the Board to publish this year a certified list of practitioners registered in medicine during the past three years, and also a list of chiropodists registered, so that the new issue, used in conjunction with the publication already at hand, will furnish a complete list to date.

Respectfully submitted,

SAMUEL H. CALDERWOOD, M.D., *Chairman.*
WALTER P. BOWERS, M.D., *Secretary.*
AUGUSTUS L. CHASE, M.D.
CHARLES H. COOK, M.D.
MICHAEL F. FALLON, M.D.
MATTHEW T. MAYES, D.O., M.D.
NATHANIEL R. PERKINS, M.D.

Public Document No. 38

THIRTY-SECOND ANNUAL REPORT

OF THE

MASSACHUSETTS BOARD OF DENTAL EXAMINERS.

FOR THE YEAR 1918.

BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
32 DERNE STREET.
1919.

Norlin, Gunhild.
Nutter, Berta Pember.
Nyhan, Nan Teresa.

O'Brien, Mary Agnes.
O'Brien, Mary Josephine.
O'Brien, Mary Victorine.
O'Connor, Elizabeth.
Ogerson, Ingeborg.
O'Grady, Mary.
Ogston, Katherine Genevieve.
O'Kane, Lucy Teresa.
Olson, Hattie Mabel Putnam.[1]
O'Malley, Anne Louise.
O'Neill, Catherine Veronica.
O'Neill, Margaret Mary.
O'Neill, Mary Catherine.
O'Rourke, Anna Maria.
Osgood, Lillian Augusta.
O'Toole, Catherine Florence.
Owen, Esther Amelia.
Owen, Mary Mingay.

Pare, Ruth Evelyn.
Park, Ruby Antoinette.
Patch, Pauline Gertrude.
Patrick, Isabella Josephine.
Patterson, Carrie Alvera.
Peacock, Ida Pearl.
Pearson, Edna Eileen.
Pearson, Margaret Louisa.
Peck, Lena Hathaway.
Pengilly, Grace Agnes.
Percy, Dora May.
Perret, Bertha Louise.
Perry, Louise Drew.
Petersen, Anna Matilda.
Petit, Berthe Lorraine.[1]
Pfaffenbach, Augusta.
Phee, Jennie.
Phelps, Gladys Emeila.
Phipps, Ora May.
Pickering, Grace Trafton.
Pierce, Esther Gertrude.
Pinckney, Elsie May.[1]
Pinkham, Susan Martha Stevens.
Pisnoy, Bessie Dorothy.
Plunkett, Elva Lenore.
Pomeroy, Marion Evelyn.
Poole, Edith Marion.
Porter, Lillian Estelle.
Postell, Elizabeth Foulk.
Potter, Adelaide.
Potter, Florence May.
Potts, Alice.[1]
Power, Hannah Agnes.
Prescott, Mildred Vivian.
Price, Marie Violet.
Proctor, Annie Laurie.
Proctor, Sophia.
Purbrick, Marian.
Purcell, Mary Agnes.

Quereau, Clara.[1]
Quist, Estrid Elizabeth.

Ramsey, Anna Agnes.
Rauh, Emma Elizabeth.
Rawson, Ethel Elizabeth.
Record, Bessie Marion.
Reed, Doris Porter.[1]
Reilly, Grace Louise.
Reilly, Ruth Gertrude.
Reynolds, Mary Ellen.
Rich, Alice May.
Richardson, Florence Kate.
Ricketts, Myrtle.
Riha, Pauline.
Riley, Lillian Estelle.
Riley, Theresa Monica.
Roan, Margaret Mary.
Robb, Ruth Esther.
Roberts, Myrtle Evelyn.
Robertson, Annie Marcilla.
Robertson, Ethel Jardine.
Robertson, Marjorie.
Robertson, Violet M.
Robinson, Jessie Wood.
Robinson, Marie Louise.
Rockwell, Gladys Muriel.
Rockwell, Helen Reta.
Rodgers, Isabelle.
Rogers, Hester Babson.
Rose, Alice May.

[1] With honor.

Ross, Anna Reinetta.
Ross, Christine.
Ross, Effie.
Rowan, Katherine.
Rowley, Ruth Frances.
Rowter, Sadie Irene.
Royce, Olive Maude.
Ruffin, Gladys Mitchell.
Rusack, Eva May.
Russell, Effie May.
Russell, Gertrude Tate.
Ryan, Edna Irene.
Ryan, Emma Catherine.
Ryan, Mary Christine.
Ryer, Eudora Evelyn.

Salsman, Laura Marion.
Sammis, Frieda Katharine.
Sandstrom, Ruth Louise.
Sargent, Estelle Barrett.
Saunders, Leila E.
Sawyer, Louise Wheeler.
Schull, Rose Marie.
Schwaller, Marjorie Geraldine.
Scott, Harriett Eliza.
Seiders, Helen Maud.
Selby, Helen Matilda.
Sewall, Etta May.
Shaw, Harriet Gladys.
Shaw, Maude Elnor.
Shea, Cecilia Mary.
Shea, Katherine Veronica.
Shea, Marion Gertrude.
Shedd, Vira Mildred.
Sheehan, Anna Josephine.
Sheehan, Ella.
Shepard, Grace Altania.
Shepherd, Annie Elizabeth.[1]
Sheridan, Mabel Cecilia.
Sherwood, Elizabeth.
Shine, Ethel Cecilia.
Short, Isabelle Louise.
Shurtleff, Ruth Inez.
Sico, Rose.
Sides, Mary Elizabeth.
Sillars, Sara Gertrude.
Simard, Ida Malvina.
Simms, Eva Ann.
Simpson, Lucy.
Sippach, Minna.
Sister Mary Thecla.[1]
Sleep, Ronello Mabel.
Sloan, Marion Edna.
Slocum, Sabra Etta.
Small, Alice Lillian.
Smith, Bessie Jean.
Smith, Charlotte Anne.
Smith, Charlotte Geddie.
Smith, Esther Perkins.
Smith, Ethel Margaret.
Smith, Florence Kate.
Smith, Flossie May.
Smith, Martha Edward.
Smith, Mary Franklin.
Smith, Rubie May.
Snider, Barbara Helen.
Snook, Elsie May.
Sopko, Theresa.
Spaulding, Nan Annette.
Spear, Katherine Emma.
Spellman, Marian Claire.
Spiers, Edith May.
Spinney, Jessie May.
Spinney, Marion Frances.
Stacy, Blanche Melvina.
Staebler, Anna May Maybee.
Stansfield, Edna.
Stanton, Gladys May.
Staples, Edith Stuart.[1]
Staples, Sarah Lois.
Steen, Georgia Adell.
Steeves, Netta May.
Stephenson, Viva Estella.
Stewart, Jennette McLeod.
Stewart, Sadie Duncan.
Stiles, Charlotte Lillian.
Stone, Florence Elaine.
Stopford, Margaret Jessie.
Stowell, Mary Buzzo.
Strang, Lillian Amanda.
Sullivan, Elizabeth Catherine.
Sullivan, Esther Mae.

[1] With honor.

The Commonwealth of Massachusetts.

BOARD OF DENTAL EXAMINERS,
BOSTON, MASS., Dec. 18, 1918.

To His Excellency SAMUEL W. McCALL, *Governor*.

SIR: — In compliance with statutory requirements the Board of Dental Examiners has the honor of submitting to you the thirty-second annual report for the year ending Nov. 30, 1918.

The commission of Joseph N. Carrière, D.D.S., of Fitchburg expired in April, and he was reappointed by Your Excellency for a term of five years.

The Board has conducted three examinations of candidates applying for registration in dentistry, and the same number for those applying to be registered as dental hygienists.

The practical work in all examinations has, as usual, been conducted at the Harvard and Tufts Dental Schools and the Forsyth Dental Infirmary, to which we are indebted for generous and courteous co-operation.

The results of the year's examinations are shown by the following: —

EXAMINATIONS OF CANDIDATES FOR REGISTRATION IN DENTISTRY.

February Examination.

Whole number examined,		113
Passed,	92	
Rejected,	21	

June Examination.

Whole number examined,		189
Passed,	158	
Rejected,	30	
Not yet acted upon,	1	

October Examination.

Whole number examined,		42
Passed,	26	
Rejected,	16	

Examination of Candidates for Registration in Dental Hygiene.

October, 1917, Examination.[1]

Whole number examined,		17
Passed,	16	
Rejected,	1	

February Examination.

Whole number examined,		2
Passed,	2	

June-July Examination.

Whole number examined,		6
Passed,	5	
Not yet acted upon,	1	

October Examination.

Whole number examined,		19
Passed,	19	

Financial Statement.

Fees from applicants received and paid into the treasury of the Commonwealth Nov. 30, 1918,	$6,421 50
Expenditures,	4,738 03
Excess receipts over expenditures,	$1,683 47

The Board has completed the triennial registration required by section 4, chapter 301, General Acts of 1915, and has published lists of the names and office addresses of all dentists registered and practicing in the State, arranged alphabetically by names and also by cities and towns in which their offices are situated.

As usual, some cases of violation of the dental law have come to the attention of the Board. All such have been referred to the department of the State Police and handled in a most satisfactory manner.

Since the establishment of this Board by the General Acts of 1887, there has been a gradual and steady increase in its duties and responsibilities. The requirements for dental edu-

[1] Final action upon these candidates not taken until December, 1918.

cation have been continually advancing and the exactions of our examination for maintaining high standards correspondingly commensurate. During the period covered by this report, 43 dental hygienists have been examined and registered by this Board, the first to be licensed in this State. The examination of this new class of candidates has materially increased the amount of time and study necessitated in the discharge of our duties. It may be noted that this Commission has always returned a substantial profit to the State. Within the last fiscal year the excess of receipts over expenditures is $1,683.47, the largest in the history of the Board, and even including the added labor and expense in securing and preparing for publication the triennial lists before mentioned. The only situation that has remained unchanged from the beginning is the financial remuneration for services of the members of the Board. This, in connection with the facts above given, we submit to your thoughtful consideration.

We recommend that the present dental law be so amended as to conform to the present four years' course of the dental schools, and that the classification of "reputable" schools also be made to conform to the general classification recently adopted by the Surgeon General of the United States as the result of an authorized and exhaustive examination by the Dental Educational Council of America.

We also recommend that there be an annual registration of the dentists practicing in this Commonwealth instead of once in three years, as at present.

All of which is respectfully submitted.

C. WESLEY HALE, *Chairman.*
GEORGE H. PAYNE, *Secretary.*

Public Document No. 39

THIRTY-THIRD ANNUAL REPORT

OF THE

MASSACHUSETTS BOARD OF REGISTRATION IN PHARMACY,

FOR THE

YEAR ENDING NOVEMBER 30, 1918.

BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
32 DERNE STREET.
1919.

Publication of this Document
approved by the
Supervisor of Administration.

CONTENTS.

NAMES OF BOARD AND OFFICERS.

JOHN F. HAYES, *President.*
JOHN J. TOBIN, *Secretary.*
WILLIAM S. BRIRY.
LEON C. ELLIS.
PERCY N. HALL.

Agent — ARTHUR W. SCOTT.

The Commonwealth of Massachusetts.

REPORT.

To His Excellency SAMUEL W. McCALL, *Governor.*

SIR: — In compliance with statute, the Board of Registration in Pharmacy respectfully presents this its thirty-third report relative to the condition of pharmacy in this Commonwealth and its official acts.

The closing of the fiscal year has been shortly preceded by the closing of the great world conflict, but war conditions will no doubt continue to affect the drug business for some time to come.

As pharmacy is both professional and mercantile it not only has shared in the business prosperity resulting from plenty of employment and high wages, but has reaped the just reward of professional skill in administering to the needs of the public throughout the year and particularly during the epidemic of influenza in the fall. The number of prescriptions filled during this period was without precedent. The success of the drug business, however, has demanded the continual readjustment of retail prices to correspond with the rising cost of drugs and ever advancing expense for clerk hire.

The year closed with 1,639 drug stores, as compared with 1,737 of the year previous. This decrease was chiefly the result of the closing of many stores on account of enlistment or draft of registered owners. Some stores also were discontinued except for the sale of simple household remedies and proprietary medicines, thus eliminating them from the list of drug stores. Fewer stores were opened. Ambitious young men who would have started new stores employed their energies in the service of their country. Others who could have

William E. Foss is Chief Engineer of Water Works and John L. Howard, Assistant to the Chief Engineer. The following are superintendents of departments under the direction of the Chief Engineer: Eliot R. B. Allardice, Superintendent of the Wachusett Department; Charles E. Haberstroh, Superintendent of the Sudbury and Cochituate Works and of the portion of the Weston Aqueduct above the Weston Reservoir; Samuel E. Killam, Superintendent in charge of the Weston Reservoir and the remaining portion of the Weston Aqueduct, and of all distributing reservoirs and pipe lines within the Metropolitan Water District; and Arthur E. O'Neil, Superintendent of the several water works pumping stations.

The average engineering force employed on construction and maintenance during the year has included, in addition to the Chief Engineer, 1 assistant to Chief Engineer, 4 department superintendents, 1 division engineer, 7 assistant engineers and 26 others in various engineering capacities, and as sanitary inspectors, clerks, stenographers and messengers, the total force numbering 40.

A maintenance force in addition to those engaged in engineering capacities, as above mentioned, numbering upon the average during the year 285, has been required at the pumping stations, upon reservoirs, aqueducts, pipe lines and upon minor construction work. At the end of the year this force numbered 255.

Frederick D. Smith is Chief Engineer of Sewerage Works. He has been assisted by Henry T. Stiff, Division Engineer in charge of the office and drafting, by 4 assistant engineers and by 11 others employed in different engineering capacities, and by 2 stenographers and clerks.

The maximum engineering force employed at any one time during the year on the construction and maintenance of the Sewerage Works was 21.

The regular maintenance force required in addition for the operation of the pumping stations, the care and inspection of the sewers, and for other parts of the Sewerage Works, exclusive of the engineers and day-labor forces, on the average has been 149.

The whole regular force of the Sewerage Department at the end of the year numbered 165, of whom the Chief Engineer and 15 assistants and draftsmen were engaged in general upon the works, and of the remainder, 91 were employed upon the North System and 58 upon the South System.

The maximum number of men employed upon contracts and upon day-labor construction on the Sewerage Works during the year was for the week ending December 21, when the number amounted to 80.

II. METROPOLITAN WATER DISTRICT.

The Metropolitan Water District now comprises the cities of Boston, Chelsea, Everett, Malden, Medford, Melrose, Newton, Quincy, Revere and Somerville, and the towns of Arlington, Belmont, Lexington, Milton, Nahant, Stoneham, Swampscott, Watertown and Winthrop, — in all 10 cities and 9 towns. The District has an area of 174.8 square miles, no additional municipalities having been admitted into the District during the year. Its population, according to the State Census taken for April 1, 1915, was 1,201,300. The population of the District on July 1, 1918, the date upon which calculations for the Water Works are based, was estimated as 1,286,770.

III. METROPOLITAN WATER WORKS — CONSTRUCTION.

The total amount expended for the construction and acquisition of the Metropolitan Water Works since the passage of the Metropolitan Water Act in the year 1895 has been $43,157,070.65.

The total amount expended during the calendar year on account of the construction and acquisition of works has been $173,238.26. The details of this expenditure are as follows: mainly on account of work to provide for an additional water supply, from the southern high service of the Metropolitan Water System, for the towns of Watertown and Belmont, $92,821.22; for work on account of the construction of the Wachusett-Sudbury transmission line, $62,543.38; and for other minor works, engineering and administration expenses, the sum of $17,873.66.

The construction of an electric transmission line from the Sudbury Dam power station to the similar station at the Wachusett Dam is now completed and the production of power at these two stations can for the future be used in the most advantageous manner.

The requirements of the United States Arsenal at Watertown and the rapid growth of other industries in that town have made necessary an enlargement of the water supply of the district comprised within the limits of Watertown and Belmont. Therefore, the Legislature, by chapter 177 of the General Acts of the year

and this Board therefore desires the privilege of continuing its representation at these meetings.

The Board has been greatly pleased with the work of its agent during the past year. He has made 1,540 inspections, this number including registered stores as well as those carrying a stock of patent medicines and household remedies. In a great many cases the agent discovered violations resulting from carelessness as to technical points in the law, and these were corrected and right systems established upon his instructions at the time. In other cases of a more serious nature, formal complaint was made to the Board, and, after hearings, the violators were punished; or, if unregistered stores, the proper authorities were notified.

Our agent found a number of stores, owned and operated by persons not registered as pharmacists, which appeared to the public as authorized drug stores because of signs bearing words such as "drug store" or "drugs." In a number of these stores drugs and medicines were found which should be sold by registered persons only. In one case hypodermic instruments were purchased by the agent without any questions being asked. Other unregistered stores confined their stock to those drugs and medicines which they could sell legally. However, in either case, one would expect to be supplied with any drug needed in sickness. This Board feels that the public should not be thus deceived as to the authority of a drug store. The present law prohibits the person who has not passed the bar examinations from advertising a law office, and imposes a penalty upon one not registered as a physician who hangs out a sign "M.D." At the present time this Board can merely request that a sign indicating a drug store be removed, but cannot insist by any authority of law. The matter could be regulated by an amendment to the statute which would prohibit a store from being represented as conducting a drug business unless so authorized by the Board of Registration in Pharmacy.

The Board is also convinced of the necessity of better safeguarding the public by some provision of statute which would prohibit stores from being continued as drug stores after the registered pharmacist to whom the permit was issued has

severed his connection with the business. This frequently occurs in stores operated by corporations in which the registered manager is not a stockholder, and in cases where a pharmacist owns two stores, one being operated by a registered clerk. It has also occurred in stores operated by widows of deceased pharmacists, where the clerk is not required to have any financial interest. In some of these instances another pharmacist has not taken charge of the store for several weeks.

The Board recommends that the law be so amended as to provide that the permit shall become void and be returned to this office when the pharmacist severs his connection with the business. If, then, another pharmacist is not immediately secured who can take out another permit for the store, the drug business can have no legal authority to be conducted until such pharmacist is obtained.

This Board believes that the legislation suggested in this report, if enacted, will operate for the best interest of pharmacy as well as for the public health.

The financial statement of the Board follows in the report of the secretary.

All of which is respectfully submitted.

JOHN F. HAYES, *President.*
JOHN J. TOBIN, *Secretary.*
WILLIAM S. BRIRY.
LEON C. ELLIS.
PERCY N. HALL.

November, 1918.

The term of William S. Briry of Melrose expires by process of law with this report. Becoming a member of the Board on Dec. 2, 1913, he has been an active worker during the past five years, serving as secretary during 1916 and 1917, and representing the Board at various meetings of the National Association of Boards of Pharmacy. The Board has appreciated his services and regrets exceedingly to part with him as a fellow member.

JOHN F. HAYES, *President.*
JOHN J. TOBIN, *Secretary.*
LEON C. ELLIS.
PERCY N. HALL.

(2) Aqueducts.

The Wachusett Aqueduct was in service for the passage of water from the Wachusett Reservoir to the Sudbury Reservoir during the whole or portions of 298 days. The quantity of water flowing through the aqueduct was equal to an average of 108,667,000 gallons per day for the entire year, which is 18,547,000 gallons more than the daily average flow in 1917. All of the water drawn from the reservoir into the aqueduct was used before its admission for the development of electric energy.

For distribution to the cities and towns of the Metropolitan District water was drawn through the Sudbury Aqueduct to the Chestnut Hill Reservoir every day in the year, the daily average for the whole year being 74,633,000 gallons, an increase of 19,080,000 gallons per day over that discharged in 1917.

The Weston Aqueduct was in use 314 days, the quantity of water delivered through the aqueduct being equivalent to a daily average of 50,512,000 gallons, a decrease of 1,567,000 gallons from that delivered in the previous year.

Water was discharged through the Cochituate Aqueduct on 12 days during the year, the total quantity of water discharged being 154,400,000 gallons.

(3) Pumping Stations.

The total amount of water pumped at all the pumping stations was 33,194,370,000 gallons, which is 9,586,350,000 gallons, or 40.61 per cent. more than in the previous year.

The following are the several pumping stations: —

	Number of Engines.	Contract Capacity per Day (Gallons).	Lift (Feet).
Chestnut Hill high-service station,	4	66,000,000	138
Chestnut Hill low-service station,	3	105,000,000	60
Chestnut Hill low-service station,	1	40,000,000	130
Spot Pond station,	2	30,000,000	125
Arlington station,	3	6,000,000	290
Hyde Park station,	2	6,000,000	140

The amount expended for the operation of the stations was $194,390.98, which is $59,175.23 more than for the year 1917.

The total amount of coal purchased during the year was 14,748.52 gross tons, of which 8,679.57 tons were bituminous and 6,068.95 tons anthracite. All of the anthracite coal was screenings. The average cost of bituminous coal delivered in the bins at the various stations varied from $7.43 to $8.75, and the average cost of anthracite coal varied from $4.82 to $5.99.

(4) Protection of the Water Supply.

The Marlborough Brook filter-beds, on which is filtered the water received from brooks passing through the thickly settled portions of Marlborough still continue adequate for the filtration of the water received.

The Pegan Brook pumping station, at which is pumped upon the filter-beds the surface drainage of about one square mile in the thickly settled portion of Natick, was in successful operation on 215 days in the year.

The filter-beds which receive for filtration the water flowing through the thickly settled portion of the town of Sterling, as well as the smaller filter-beds which receive the drainage from a few houses near Sterling Junction, the Worcester County Training School at West Boylston and from the swimming pool at Southborough, have been in successful operation and required only the usual attention during the year.

Studies for the disposal of manufacturing wastes, as well as for the disposal of house drainage from the various towns within the drainage area of the Metropolitan Water System, have been in progress during the year.

Constant inspection of the watersheds has been maintained by the Sanitary Inspector and his assistants and members of the maintenance force. It is a well-earned tribute to the sanitary administration of the Wachusett water district that not a single case of typhoid has been found there during the past year.

Chemical examinations of the waters used were made by the State Department of Health, and in addition, microscopical and bacterial examinations were made by the Board. These examinations enable the Board to take measures to remedy any difficulties which are found to exist.

The quality of the water brought to the Metropolitan District continues to be satisfactory both in taste and appearance. This

Obituary.

Alfred D. Adams, Roslindale.
Daniel W. Adams, Stoneham.
William D. Barnes, Orange.
John D. Barry, Lynn.
Charles Bass, Boston.
Eliza G. H. Brackett, Woburn.
Patrick H. Burke, Lynn.
Albert H. P. Byers, Lynn.
John F. Cahill, Cambridge.
Joseph E. Chenette, Indian Orchard.
Orrin B. Cole, Bridgewater.
Alice G. Coleman, Nantucket.
James W. Cooper, Plymouth.
Harry B. Davenport, Plymouth.
Henry H. Dudley, Bridgewater.
George A. Elliott, Holyoke.
Howard B. Foster, Gloucester.
Victor G. Garland, Gloucester.
George A. Garratt, Somerville.
Arthur Gavin, Malden.
Clarence K. Graves, Northampton.
N. Lawton Graves, Hyde Park.
Abraham Gerstein, Lawrence.
Burke L. Grindle, Roxbury.
Henry C. Hall, Waltham.
Edward S. Hanson, Taunton.
Ernest F. Hayward, Wollaston.
Helen C. Healey, Lawrence.
Jesse E. Henry, Holyoke.
Gustavus Jones, Brockton.
Charles H. King, Williamstown.
Arthur Lamson, Upton.
George A. Letellier, Winthrop.
Alfred S. Letourneau, Fall River.
John C. Lowd, Dorchester.
Amedee Martel, Turners Falls.
Honorat J. Masse, New Bedford.
Raymond D. McGrath, Malden.
Walter Merrill, Newton.
Peter J. Moran, Clinton.
John J. Murphy, Holyoke.
Joseph Musman, Malden.
Eben G. Page, Manchester.
Melvin H. Perkins, Gloucester.
Philip E. Reidy, Peabody.
Edward L. Rogers, Middleton.
Albert B. Smith, Lawrence.
G. Chester Spalding, Andover.
John W. Tirrell, Canton.
Leo J. Woodcomb, Fitchburg.
James T. Young, Dorchester.

SUMMARY.

Meetings: —	
For examinations,	8
For hearings,	24
Hearings: —	
In relation to charges affecting personal registration,	16
In relation to the granting or suspension of liquor certificates,	39
In relation to the granting or suspension of drug store permits,	33
In relation to reciprocity, duplicate certificates and miscellany,	14
Results of hearings: —	
Number of certificates of personal registration suspended,	1
Number of sixth-class license certificates suspended,	5
Number of certificates of fitness suspended,	10
Number of permits refused to intended drug stores,	5
Number of permits refused until conditions were changed to conform with the law,	5
Number of liquor certificates refused,	6
Number of permits revoked,	1

Respectfully submitted,

JOHN J. TOBIN,
Secretary.

Public Document **No. 91**

NINTH ANNUAL REPORT

OF THE

BOARD OF REGISTRATION OF NURSES

FOR THE YEAR ENDING DEC. 31, 1918

BOSTON
WRIGHT & POTTER PRINTING CO., STATE PRINTERS
32 DERNE STREET
1919

The Wachusett watershed yielded a daily average of 902,000 gallons per square mile, which is 85.5 per cent. of the average for the past twenty-two years, and the Sudbury watershed yielded a daily average of 736,000 gallons per square mile, which is 75.49 per cent. of the average for the past forty-four years. The yield from the Cochituate watershed was 758,000 gallons per day per square mile, which is 82.75 per cent. of the average for the past fifty-six years.

(10) WATER CONSUMPTION.

During the year the quantity of water supplied to the Metropolitan Water District amounted to a daily average of 129,764,000 gallons as measured by Metropolitan Water Works meters, which was equivalent to 105 gallons for each person in the District. This quantity was 19,731,700 gallons more than the average daily consumption of the preceding year. This large increase seems to have been partly due to the waste of water to prevent freezing of service pipes.

Acting under authority conferred by several statutes and arrangements which have been made, water has been supplied to a limited extent outside of the Metropolitan Water District. There has been drawn from the open channel of the Wachusett Aqueduct for the use of the Westborough State Hospital a daily average quantity of 163,700 gallons. The town of Framingham has, under the provisions of the statute, drawn indirectly from Farm Pond a daily average quantity of 538,630 gallons and directly from the Sudbury Aqueduct 635,616 gallons. A portion of the town of Saugus has been supplied through the city of Revere with an average of 44,900 gallons daily. The United States Government, for use on Peddock's Island, has been supplied with a daily average of 134,900 gallons. The sums charged for the water thus supplied have amounted to $11,198.89.

V. WATER WORKS — FINANCIAL STATEMENT.

The financial abstract of the receipts, disbursements, assets and liabilities of the Board for the State fiscal year, beginning with December 1, 1917, and ending with November 30, 1918, was, in accordance with the requirements of chapter 235 of the Acts of the year 1906, presented to the General Court in January last, and a copy of this financial abstract is printed as Appendix No. 5.

As required by said chapter a detailed statement of its doings for the calendar year 1918, in relation to the Metropolitan Water Works, is herewith presented.

Construction.

(1) Water Loans — Receipts and Payments.

Total loans authorized to January 1, 1919,		$42,913,000 00
Receipts from the sales of property applicable to the construction and acquisition of works: —		
For the period prior to January 1, 1918,	$253,845 45	
For the year ending December 31, 1918,	3,491 41	
		257,336 86
Receipt from the town of Swampscott for admission to District (St. 1909, c. 320),		90,000 00
Total amount authorized to January 1, 1919,		$43,260,336 86
Amounts approved by Board for payments out of Water Loan Fund: —		
Payments prior to January 1, 1918,	$42,983,832 39	
Approved for year ending December 31, 1918,	173,238 26	
		43,157,070 65
Amount authorized but not expended January 1, 1919,		$103,266 21

(2) Total Water Debt, December 31, 1918.

Water Loan Outstanding, Sinking Fund and Debt.

Bonds issued by the Treasurer of the Commonwealth: —		
Sinking fund bonds (3 and 3½ per cent.),		$41,398,000 00
Serial bonds (3½ and 4 per cent.),		1,354,000 00
Total bond issue to December 31, 1918,		$42,752,000 00
Serial bonds paid prior to January 1, 1918,	$104,000 00	
Serial bonds paid in 1918,	37,000 00	
		141,000 00
Total bond issue outstanding December 31, 1918,		$42,611,000 00
Gross Water Debt,		$42,611,000 00
Sinking fund December 31, 1918,		14,870,834 84
Net Water Debt December 31, 1918,		$27,740,165 16

A decrease for the year of $871,555.96.

(3) Metropolitan Water Loan and Sinking Fund, December 31, 1918.

Year.	Authorized Loans.	Bonds issued (Sinking Fund).	Bonds issued (Serial Bonds).	Sinking Fund.
1895,	$27,000,000	$5,000,000	-	$226,286 05
1896,	-	2,000,000	-	699,860 70
1897,	-	6,000,000	-	954,469 00
1898,	-	4,000,000	-	1,416,374 29
1899,	-	3,000,000	-	1,349,332 97
1900,	-	1,000,000	-	1,573,619 72
1901,	13,000,000	10,000,000	-	1,662,426 95
1902,	-	3,500,000	-	2,256,803 81
1903,	-	1,500,000	-	2,877,835 59
1904,	-	2,500,000	-	3,519,602 92
1905,	-	650,000	-	4,207,045 69
1906,	500,000	1,350,000	-	4,897,822 62
1907,	-	-	-	5,643,575 69
1908,	398,000	-	-	6,419,283 28
1909,	900,000	398,000	-	7,226,262 31
1910,	80,000	500,000	-	8,089,903 91
1911,	212,000	-	$200,000	8,953,437 44
1912,	600,000	-	190,000	9,829,356 80
1913,	108,000	-	-	10,767,701 68
1914,	-	-	258,000	11,533,453 45
1915,	-	-	490,000	12,491,245 25
1916,	-	-	66,000	13,268,199 26
1917,	-	-	150,000	14,036,278 88
1918,	115,000	-	-	14,870,834 84
	$42,913,000	$41,398,000	$1,354,000	-

(4) Water Assessment, 1918.

The following water assessment was made by the Treasurer of the Commonwealth upon the various municipalities: —

Sinking fund requirements,		$262,039 38
Serial bonds,		37,000 00
Interest,		1,476,460 54
Maintenance: —		
Appropriated by Legislature,	$601,500 00	
Less balance on hand,	62,702 61	
		538,797 39
Total water assessment for 1918,		$2,314,297 31

In accordance with chapter 488, Acts of 1895, as amended in 1901, 1904 and 1906, the proportion to be paid by each city and town is based one-third in proportion to their respective valuations and the remaining two-thirds in proportion to their respective water consumption for the preceding year, except that but one-fifth of the total valuation and no consumption has been taken for the city of Newton, as it has not been supplied with water from the Metropolitan Works.

The division of the assessment for 1918 was as follows: —

Cities and Towns.	Assessment.	Cities and Towns.	Assessment.
Arlington,	$21,735 89	Nahant,	$3,848 67
Belmont,	11,402 54	Newton,	5,832 03
Boston,	1,741,008 84	Quincy,	57,975 46
Chelsea,	58,047 20	Revere,	32,414 05
Everett,	57,838 91	Somerville,	125,358 55
Lexington,	9,398 37	Stoneham,	10,009 34
Malden,	49,949 48	Swampscott,	12,351 41
Medford,	36,487 21	Watertown,	31,143 50
Melrose,	20,222 33	Winthrop,	16,843 44
Milton,	12,430 09		$2,314,297 31

(5) Supplying Water to Cities and Towns outside of District and to Water Companies.

Sums have been received during the year 1918 under the provisions of the Metropolitan Water Act, for water furnished, as follows: —

Town of Framingham,	$7,280 58
City of Revere (on account of water furnished to a portion of the town of Saugus for 1917),	270 00
United States Government (for Peddock's Island),	2,495 57
Westborough State Hospital,	2,068 11
	$12,114 26

The sums so received prior to March 23, 1907, were annually distributed among the cities and towns of the District; but since that date, in accordance with the provisions of chapter 238 of the Acts of 1907, the sums so received have been paid into the sinking fund.

(6) Expenditures for the Different Works.

The following is a summary of the expenditures made in the various operations for the different works: —

Construction and Acquisition of Works.	For the Year ending December 31, 1918.	
Administration applicable to all parts of the construction and acquisition of the works,		$3,287 26
Wachusett Department, real estate,		32 00
Power Plant at Sudbury Dam,		22 90
Wachusett-Sudbury Power Transmission Line,		62,543 38
Distribution system: —		
Southern high service: —		
Section 47 (additional water supply for Watertown and Belmont),	$92,221 22	
Real estate,	000 00	
Northern extra high service: —		
New pumping engine at Arlington pumping station,	19,623 18	
Southern extra high service: —		
Section 44 (12-inch connection in West Roxbury),	101 50	
Meters and connections,	49 75	
		112,506 65
Stock — pipes, valves, castings, etc., purchased and sent first to storage yards, and later transferred, as needed, to the various parts of the work: —		$178,581 19
Amount received,	$51,018 34	
Transferred from storage yards to the various sections of the work and included in costs of special works,	56,361 27	
Deduct excess of transfers over amount purchased during year,		5,342 93
		$173,238 26
Amount charged from beginning of work to January 1, 1918,		42,983,832 39
Total for construction and acquisition of works to January 1, 1919,		$43,157,070 65

Maintenance and Operation.	For the Year ending December 31, 1918.	
Administration,		$15,777 69
General supervision,		33,921 55
Taxes and other expenses,		43,539 54
Wachusett Department: —		
Superintendence,	$7,359 43	
Reservoir,	4,815 12	
Forestry,	14,860 00	
Protection of supply,	4,321 47	
Buildings and grounds,	4,549 22	
Wachusett Dam,	8,086 22	
Wachusett Aqueduct,	11,517 24	
Clinton sewerage system: —		
Pumping station,	2,091 64	
Sewers, screens and filter-beds,	8,051 43	
Sanitary inspection,	334 81	
Swamp drainage,	3,202 22	
Power plant,	10,379 05	
Wachusett-Sudbury Power Transmission Line,	301 66	
Payments under Industrial Accident Law and special benefit appropriations,	497 05	
		80,366 56
Sudbury Department: —		
Superintendence, Framingham office,	$10,986 53	
Ashland Reservoir,	3,053 30	
Hopkinton Reservoir,	1,859 11	
Whitehall Reservoir,	1,126 91	
Framingham Reservoirs Nos. 1, 2 and 3,	13,726 87	
Sudbury Reservoir,	10,328 81	
Lake Cochituate,	10,364 70	
Marlborough Brook filters,	2,629 70	
Pegan filters,	5,406 63	
Sudbury and Cochituate watersheds,	2,113 47	
Sanitary inspection,	3,389 21	
Cochituate Aqueduct,	2,894 25	
Sudbury Aqueduct,	10,738 18	
Weston Aqueduct,	9,271 08	
Forestry,	8,219 18	
Power plant,	11,721 68	
Payments under Industrial Accident Law and special benefit appropriations,	480 64	
		108,310 20
Distribution Department: —		
Superintendence,	$6,061 13	
Pumping service: —		
Superintendence,	4,641 10	
Payments under Industrial Accident Law and special benefit appropriations,	154 50	
Arlington pumping station, pumping service,	13,983 42	
Chestnut Hill low-service pumping station, pumping service,	105,164 64	
Chestnut Hill high-service pumping station, pumping service,	31,308 10	
Spot Pond pumping station, pumping service,	28,536 42	
Hyde Park pumping station, pumping service,	10,602 80	
Amounts carried forward,	$200,452 11	$281,915 54

Maintenance and Operation.	For the Year ending December 31, 1918.	
Amounts brought forward,	$200,452 11	$281,915 54
Distribution Department — *Con.*		
Bear Hill Reservoir,	217 94	
Chelsea Reservoir,	194 98	
Chestnut Hill Reservoir and grounds,	11,850 50	
Fells Reservoir,	989 50	
Forbes Hill Reservoir,	1,695 66	
Mystic Lake, conduit and pumping station,	1,902 54	
Mystic Reservoir,	706 46	
Arlington standpipe,	25 00	
Waban Hill Reservoir,	263 67	
Weston Reservoir,	4,052 14	
Spot Pond,	8,224 24	
Buildings at Spot Pond,	2,191 16	
Pipe lines: —		
Low service,	24,142 50	
Northern high service,	7,044 87	
Northern extra high service,	171 67	
Southern high service,	6,885 54	
Southern extra high service,	149 56	
Supply pipe lines,	971 82	
Buildings at Chestnut Hill Reservoir,	5,257 61	
Chestnut Hill pipe yard,	1,588 10	
Glenwood pipe yard and buildings,	2,420 82	
Stables,	8,387 66	
Venturi meters,	1,231 30	
Measurement of water,	2,366 14	
Arlington pumping station, buildings and grounds,	351 52	
Hyde Park pumping station, buildings and grounds,	121 94	
Fisher Hill Reservoir,	3,881 02	
Bellevue Reservoir,	244 19	
Payments under Industrial Accident Law and special benefit appropriations,	751 61	
		298,833 77
Total for maintaining and operating works,		$580,749 31

(7) Detailed Financial Statement under Metropolitan Water Act.

The Board herewith presents, in accordance with the requirements of the Metropolitan Water Act, a detailed statement of the expenditures and disbursements, receipts, assets and liabilities for the year 1918.

(a) *Expenditures and Disbursements.*

The total amount of the expenditures and disbursements on account of construction and acquisition of works for the year beginning January 1, 1918, and ending December 31, 1918, was $173,238.26,

and the total amount from the time of the organization of the Metropolitan Water Board, July 19, 1895, to December 31, 1918, has been $43,157,070.65.

For maintenance and operation the expenditures for the year were $580,749.31.

The salaries of the commissioners, and the other expenses of administration, have been apportioned to the construction of the works and to the maintenance and operation of the same, and appear under each of those headings.

The following is a division of the expenditures according to their general character: —

General Character of Expenditures.	For the Year ending December 31, 1918.	
Construction of Works and Acquisition by Purchase or Taking.		
Administration.		
Commissioners,	$1,141 67	
Secretary,	550 00	
Clerks and stenographers,	970 53	
Stationery and printing,	268 82	
Postage, express and telegrams,	60 00	
Telephone, lighting, heating, water and care of building,	175 21	
Rent and taxes, main office,	221 03	
		$3,387 26
Engineering.		
Chief engineer,	$20 00	
Principal assistant engineers,	1,120 80	
Engineering assistants,	2,585 83	
Consulting engineers,	16 00	
Inspectors,	1,425 00	
Railroad and street car travel,	118 84	
Stationery and printing,	59 37	
Engineering and drafting instruments and tools,	2 75	
Engineering and drafting supplies,	25 70	
Books, maps and photographic supplies,	24 96	
Telephone, lighting, heating, water and care of buildings: —		
Main office,	525 73	
Rent and taxes, main office,	663 10	
Miscellaneous expenses,	126 32	
		6,714 40
Construction.		
Preliminary work: —		
Advertising,		28 43
Contracts, Distribution System: —		
F. C. Alexander, for furnishing and laying granite and seam face masonry for extension of coal pocket at the northern extra high-service pumping station at Arlington, Mass., Contract 390,	$1,119 00	
Amounts carried forward,	$1,119 00	$10,130 09

General Character of Expenditures.	For the Year ending December 31, 1918.	
Amounts brought forward,	$1,119 00	$10,130 09
Construction — Con.		
Contracts, Distribution System — *Con.*		
Builders Iron & Steel Co., for furnishing steelwork for the extension of coal pocket at the northern extra high-service pumping station at Arlington, Mass., Contract 386,	620 00	
New England Iron Works Co., for furnishing 54-inch horizontal fire tube boiler and appurtenances for the northern extra high-service pumping station at Arlington, Mass., Contract 383,	2,324 51	
F. A. Massur & Co., for furnishing and installing a centrifugal pumping unit at the northern extra high-service pumping station at Arlington, Mass., Contract 382,	4,880 00	
Michele DeSisto, for laying water pipes on Section 47, southern high service (additional water supply for Watertown and Belmont), Contract 387,	26,630 68	
U. S. Cast Iron Pipe & Foundry Co., for furnishing cast-iron water pipes and special castings, Contract 388,	43,923 15	
U. S. Cast Iron Pipe & Foundry Co., for furnishing flexible jointed pipe and special sleeves, Contract 389,	2,221 37	
Contract, Wachusett-Sudbury Power Transmission Line: —		
Fred T. Ley & Co., Inc., for constructing an electric power transmission line between the Wachusett Power Station in Clinton, Mass., and the Sudbury Power Station in Southborough, Mass., Contract 385,	61,581 00	
		143,299 71
Additional work: —		
Labor,	$6,597 42	
Freight and express,	172 24	
Tools, machinery, appliances and hardware supplies,	465 43	
Electrical supplies,	214 72	
Castings, ironwork and metals,	1,028 77	
Iron pipe and valves,	4,856 37	
Paint and coating,	463 75	
Lumber and field buildings,	594 57	
Brick, cement and stone,	1,146 28	
Sand, gravel and filling,	49 95	
Municipal and corporation work,	3,147 23	
Unclassified supplies,	84 96	
Miscellaneous expenses,	254 29	
		19,020 96
Real Estate.		
Legal and expert: —		
Conveyancing expenses,	$105 48	
Miscellaneous expenses,	50 00	
Settlements made by the Board,	632 00	
		787 48
		$173,238 26
Amount charged from beginning of work to January 1, 1918,		42,983,832 39
Total amount of construction expenditures to January 1, 1919,		$43,157,070 65

General Character of Expenditures.	For the Year ending December 31, 1918.	
Maintenance and Operation of Works.		
Administration: —		
Commissioners,	$6,208 33	
Secretary and assistants,	6,479 54	
Rent,	574 57	
Repairs of building,	4 20	
Fuel,	86 78	
Lighting,	52 74	
Care of building,	561 32	
Postage,	165 00	
Printing, stationery and office supplies,	1,189 94	
Telephones,	124 17	
Traveling expenses,	134 75	
Miscellaneous expenses,	196 35	
		$15,777 69
General supervision: —		
Chief engineer and assistants,	$26,594 55	
Rent,	1,723 70	
Repairs of building,	197 56	
Fuel,	260 34	
Lighting,	163 15	
Care of building,	1,684 35	
Postage,	122 00	
Express and telegrams,	182 69	
Printing, stationery and office supplies,	614 25	
Telephones,	435 55	
Traveling expenses,	1,323 05	
Miscellaneous expenses,	670 36	
		33,921 55
Pumping service: —		
Superintendence,	$4,641 10	
Labor,	86,050 34	
Fuel,	93,428 59	
Oil, waste and packing,	2,088 82	
Repairs,	6,272 44	
Small supplies,	1,755 19	
Payments under Industrial Accident Law and special benefit appropriations,	154 50	
		194,390 98
Reservoirs, aqueducts, pipe lines, buildings and grounds: —		
Superintendents,	$7,320 00	
Engineering assistants,	12,334 01	
Sanitary inspectors,	3,096 76	
Labor, pay roll,	208,968 58	
Labor, miscellaneous,	3,983 03	
Alterations and repairs of pumping stations,	1,861 73	
Amounts carried forward,	$237,559 11	$244,090 22

General Character of Expenditures.	For the Year ending December 31, 1918.	
Amounts brought forward,	$237,559 11	$244,090 22
Reservoirs, aqueducts, pipe lines, buildings and grounds — *Con.*		
Alterations and repairs of other buildings and structures,	2,476 65	
Automobiles,	7,755 35	
Brick,	192 10	
Brooms, brushes and janitor's supplies,	353 04	
Castings, ironwork and metals,	1,123 08	
Cement and lime,	470 49	
Drafting and photo supplies,	217 36	
Electrical supplies,	3,590 57	
Fertilizer and planting material,	318 72	
Freight and express,	691 06	
Fuel,	3,714 54	
Gypsy moth supplies,	3,962 34	
Hardware,	2,240 34	
Hay and grain,	1,199 90	
Lighting,	300 34	
Lumber,	1,902 71	
Machinery,	1,914 09	
Paints and oils,	1,829 39	
Pipe and fittings,	913 59	
Postage,	171 02	
Printing, stationery and office supplies,	826 41	
Rubber and oiled goods,	256 90	
Stable expenses,	1,052 81	
Sand, gravel and stone,	340 37	
Traveling expenses,	2,857 90	
Telephones,	1,694 89	
Teaming,	3,753 68	
Tools and appliances,	2,437 09	
Vehicles, harnesses and fittings,	162 61	
Miscellaneous expenses,	3,766 85	
Contracts: —		
The Pelton Water Wheel Co., Contract 60-M, for furnishing one 18-inch Pelton motor and one 2½ kilowatt 110-volt direct current generator for electric lights at Spot Pond Pumping Station and foreman's house,	545 00	
Union Gear & Machine Co., Contract 61-M, for making and delivering head gate hoists for Wachusett Aqueduct,	800 00	
Payments under Industrial Accident Law and special benefit appropriations,	1,729 30	
		293,119 55
Payments in lieu of taxes,		43,539 54
Total expenditures for maintenance and operation,		$580,749 31

(b) *Receipts.*

The total amount of receipts from the operations of the Board and from sales of property for the year beginning January 1, 1918, and ending December 31, 1918, was $105,686.83, and the total amount

from the time of the organization of the Metropolitan Water Board, July 19, 1895, to December 31, 1918, has been $1,498,377.70. The general character of these receipts is as follows: —

General Character of Receipts.	For the Year ending December 31, 1918.	
Applicable to the loan fund: —		
Construction tools, supplies and reimbursements,		$3,491 41
Applicable to payment of interest, sinking fund requirements and expenses of maintenance and operation: —		
Proceeds from operations of the Board: —		
Rents,	$1,868 00	
Land products,	5,585 18	
Electric energy,	78,376 23	
Maintenance labor, tools, supplies and reimbursements,	4,154 55	
Interest and unclassified receipts,	97 20	
		90,081 16
Applicable to the sinking fund: —		
Water supplied to cities and towns, water companies and others,		12,114 26
		$105,686 83
Amount credited from beginning of work to January 1, 1918,		1,392,690 87
Total receipts to January 1, 1919,		$1,498,377 70

The foregoing receipts have been credited to the various objects or works, as follows: —

Sources of Receipts.	For the Year ending December 31, 1918.	
Supplying water outside of Water District,		$12,114 26
Construction and acquisition of works: —		
Administration,	$41 02	
Distribution system,	3,490 91	
		3,531 93
Maintenance and operation of works: —		
Administration,	$248 11	
General supervision,	581 22	
Wachusett Aqueduct,	622 62	
Wachusett Reservoir,	4,231 41	
Wachusett electric power plant,	42,418 00	
Sudbury system,	2,921 71	
Sudbury electric power plant,	35,958 23	
Distribution system,	2,375 03	
Clinton sewerage system,	734 31	
		90,040 64
		$105,686 83
Amount credited from beginning of work to January 1, 1918,		1,392,690 87
Total receipts to January 1, 1919,		$1,498,377 70

(c) *Assets.*

The following is an abstract of the assets of the Water Works, a complete schedule of which is kept on file in the office of the Board: —

Office furniture, fixtures and supplies; engineering and scientific instruments and supplies; police supplies; horses, vehicles, field machinery, etc.; machinery, tools and other appliances and supplies; completed works, real estate and buildings connected therewith.

(d) *Liabilities.*

The sums due on monthly pay rolls amount to $411.94 and there are bills for current expenses which have not yet been received.

Amounts on Monthly Estimates, not due until Completion of Contracts or until Claims are settled.

Name.	Work.	Amount.
Joseph Hanreddy,	Contract 314, Section 7 of the Weston Aqueduct Supply Mains, in Newton, Mass.	$10 00
F. A. Massur & Co.,	Contract 382, for furnishing and installing a centrifugal pumping unit at the northern extra high-service pumping station at Arlington, Mass.	970 00
Michele DeSisto,	Contract 387, Section 47 of southern high-service pipe line (additional water supply for Watertown and Belmont).	4,699 53
U. S. Cast Iron Pipe and Foundry Co.,	Contract 388, for cast-iron pipe and special castings for the Distribution System.	7,751 15

Settlements are pending with the following parties for land and easements taken in lands owned by them: —

D. Blakeley Hoar and George R. Nutter, New York, New Haven & Hartford Railroad Company, Frederique Ropp.

VI. METROPOLITAN SEWERAGE WORKS.

The North Metropolitan Sewerage District embraces the cities of Cambridge, Chelsea, Everett, Malden, Medford, Melrose, Revere, Somerville and Woburn, and the towns of Arlington, Belmont, Reading, Stoneham, Wakefield, Winchester and Winthrop and parts of the city of Boston and the town of Lexington, — comprising in all 10 cities and 8 towns, with an area of 100.32 square miles. The district has an estimated population, based upon the census of 1915, as of December 31, 1918, of 646,270. Of the total population it is

estimated that 89.7 per cent., or 579,440 people, contribute sewage to the North Metropolitan System.

The South Metropolitan Sewerage District includes the cities of Newton, Quincy and Waltham, and the towns of Brookline, Milton, Watertown and Wellesley, and parts of the city of Boston and the town of Dedham, — a total of 4 cities and 5 towns. This district has an area of 110.76 square miles, with an estimated population as of December 31, 1918, of 491,200. According to the estimates made 75.9 per cent. of this population, or 372,980, contribute sewage to the South Metropolitan System.

(1) North Metropolitan Sewerage System — Construction.

The amount expended for construction on account of the North Metropolitan System during the past year was $35,738.27.

The extension of the Deer Island outfall, authorized by chapter 344 of the Acts of 1914, has been completed and for the past year the sewage of the district has been discharged through the new openings. A carefully contrived distribution of the effluent matters over a considerable area at a distance below the surface of the harbor offers the best obtainable solution of the nuisance hitherto existing. Observation at this season of the year has shown the method to be successful.

By chapter 159 of the Acts of 1916 the town of Reading became a part of the North Metropolitan Sewerage District and has thus far complied with all the terms of payment provided by the statute. The plans for the construction of the necessary connecting sewer have been made, but no contractor has been found who is willing to undertake its construction within the limits of the appropriation made for this purpose. The Board, however, found that a profitable use could be made of the plant of Bruno & Petitti, who were about completing certain sewer work for the town of Reading and had on hand all the apparatus necessary for sewer construction and, believing that it was not probable in the near future that any contractors could more economically perform the work upon a limited portion of the projected sewer than these competent contractors, made a contract with them for the construction of 1,370 feet of sewer in open cut in direct continuation of the sewer already constructed in the town of Reading. This work has been successfully prosecuted and will probably be finished in the coming spring.

The Board has had under consideration some modification of the plan adopted by the joint commission in July, 1914, in the hope that a satisfactory disposal of the sewage of the town of Reading may be obtained for a dozen years at least at a reasonable cost.

The Board acquired by taking during the year easements in 1.299 acres of land in Reading, Stoneham and Wakefield for the construction of the Reading extension of the North Metropolitan Sewerage System.

(2) North Metropolitan Sewerage System — Maintenance.

The cost of the maintenance and operation of the North Metropolitan System during the past year was $230,021.71.

Sewers and Pumping Stations.

The metropolitan sewers in the North Metropolitan System now extend a distance of 64.028 miles, and the local sewers which are connected with the metropolitan sewers have a further length of 774.30 miles, involving 84,773 connections.

The sewage of the North Metropolitan District flows at first by gravity, but before being finally disposed of is lifted at different points by pumping and is finally discharged into the harbor from an outfall off Deer Island.

The daily average amount of sewage discharged into the harbor was 66,500,000 gallons, a daily average for each person contributing sewage of 115 gallons. The increase in the total amount of sewage discharged was 1,900,000 gallons per day more than the discharge of the preceding year. The maximum rate of discharge in any one day was 163,000,000 gallons.

The pumping stations operated for the North Metropolitan Sewerage System are as follows: —

	Number of Engines.	Contract Capacity per Day (Gallons).	Lift (Feet).
Deer Island station (Boston Harbor),	4	235,000,000	19
East Boston station,	4	235,000,000	19
Charlestown station,	3	104,000,000	11 8
Alewife Brook station (Somerville),	3	22,000,000	13

There were purchased for the operation of the pumping stations 7,020 tons of bituminous coal and 40 tons of anthracite screenings, the average prices of which, at the different stations, varied from $10.74 to $11.31 per gross ton for the bituminous coal and from $5.30 to $7.11 for the screenings, delivered in the bins.

The amount expended for the stations was $162,012.39. The average cost per million gallons of sewage lifted per foot at the several stations was $0.214, an increase of 35 per cent. over the cost last year.

(3) South Metropolitan Sewerage System — Construction.

The amount expended for construction on account of the South Metropolitan System during the past year was $115,596.89.

The town of Wellesley was admitted to the South Metropolitan Sewerage District by chapter 343 of the Acts of 1914, and the act was accepted by the town in March, 1915.

The original estimate for the construction of the Wellesley extension, High-level sewer, of $350,000, was made by the State Board of Health, and was based on a report submitted by an engineer called in by that department to make a survey and estimate. Two lines were considered by the Board of Health. The estimate was made on the shorter line which came through the location of the Brookline Water Works fields. This line was to connect with the existing Neponset Valley sewer of the High-level System at a point where the sewer has a capacity suitable only for the original district for which it was built.

Because of the small size of this existing Metropolitan sewer and the fact that this line extended across the Brookline Water Works fields and would interfere with this important supply, and also because of the fact that there is a rapidly growing portion of Dedham in the vicinity of Bridge Street which is a part of the Metropolitan District and has no possible means of reaching the Metropolitan System, excepting by construction work by the Metropolitan Water and Sewerage Board, it was decided to use the alternate line proposed by the State Board of Health.

The line adopted has a length of about 40,000 feet almost wholly through private lands. The natural physical conditions in this part of the Charles River valley make sewer construction very expensive. This is occasioned by the large amount of rock encountered and by

fine sands and other material in which it is expensive to construct and by the remoteness of the location.

Because of the above-stated conditions, namely, insufficiency of the original appropriation, not based on estimates made by the Metropolitan Water and Sewerage Board, and the necessary changes in the location to fit the needs of the District, the bad material encountered and, above all, the abnormal conditions of the market in regard to labor and supplies, an additional appropriation of $325,000 was made by the Legislature of 1917. It is not probable that the remainder of this work, consisting of nearly three sections of the nine into which the whole line was divided, can be completed within the appropriation. The contractor for one of the sections undertaken in the year 1917 found difficulties in carrying out his contract so serious that he felt obliged to abandon the work before any permanent construction of the sewer had been effected. The Board then took over the work under the oversight of a sewer builder of much experience and the undertaking has been successfully carried on under great difficulties and is now substantially completed, but at a very large increase in expense over the contract price.

Borings along the line of the proposed sewer were made in the usual manner and samples of the materials found in the borings were exhibited to those who proposed to bid for the work, but even experienced contractors misjudged the probable behavior of these materials and the cost of the work has far outrun the estimates.

An appropriation of $225,000 has been asked for the completion of this sewer of which more than two-thirds has been finished, but even now the Board makes any estimate of probable cost with much hesitation.

(4) South Metropolitan Sewerage System — Maintenance.

The entire cost of maintenance of the South Metropolitan System during the past year was $155,874.58.

Sewers and Pumping Stations.

The metropolitan sewers in the South Metropolitan System, which comprise the old Charles River valley sewer and Neponset River valley sewer, as well as the new High-level sewer and extensions, have a total length of 49.212 miles, and with these are connected

local sewers having a length of 658.10 miles, involving 45,598 connections.

The pumping stations operated for the South Metropolitan Sewerage system are as follows: —

	Number of Engines.	Contract Capacity per Day (Gallons).	Lift (Feet).
Ward Street station (Roxbury District),	2	100,000,000	45
Quincy station,	3	18,000,000	28
Quincy sewerage lifting station,	2	3,000,000	20

The sewage of two small areas in Dorchester and Milton, included in the Neponset River valley system, which are too low for sewage to be delivered into the High-level sewer by gravity, is, under an arrangement with the city of Boston, disposed of through the Boston Main Drainage Works at Moon Island. By this arrangement the Board is relieved from the expense of providing extra pumping facilities.

A large part of the sewage of the South District is lifted into the High-level sewer at the Ward Street pumping station in Roxbury. Most of the sewage of the city of Quincy is pumped into the High-level sewer at Greenleaf Street near the Quincy pumping station. All of the sewage of the South District is screened at the Nut Island screen-house for the purpose of intercepting solid matter, and is thence discharged at the bottom of the harbor from the outfalls about a mile off the island.

The daily average amount of sewage thus discharged was 56,-200,000 gallons, and the largest rate of discharge in a single day was during a heavy storm, when the amount reached 152,500,000 gallons. The decrease in the daily average from last year was 4,000,000 gallons. The daily average discharge of sewage for each individual contributing sewage in the district was 151 gallons.

There were 3,908 gross tons of bituminous coal and 15 tons of anthracite screenings purchased at the two pumping stations and the Nut Island screen-house, the average prices of which varied from $9.54 to $11.51 per gross ton for the bituminous coal delivered in the bins. The screenings were purchased for $7.74 per ton.

The total amount expended for the operation of the stations was $102,822.28.

VII. SEWERAGE WORKS — FINANCIAL STATEMENT.

The financial abstract of the receipts, expenditures, disbursements, assets and liabilities of the Metropolitan Water and Sewerage Board for the fiscal year of the Commonwealth ending with November 30, 1918, was, as stated in connection with the Water Works, presented to the General Court in January, in accordance with the requirements of chapter 235 of the Acts of the year 1906, and a copy of this financial abstract is in part printed as Appendix No. 5.

The following statement of its financial doings, in relation to the Metropolitan Sewerage Works, for the calendar year 1918 is herewith presented, in accordance with the provisions of the act of 1906, as a part of the annual report of the Board.

(1) Metropolitan Sewerage Loans, Receipts and Payments.

The loans authorized for the construction of the Metropolitan Sewerage Works, the receipts which are added to the proceeds of these loans, the expenditures for construction, and the balances available on January 1, 1919, have been as follows: —

North Metropolitan System.

Loans authorized under various acts to January 1, 1919, for the construction of the North Metropolitan System and the various extensions,		$7,512,365 73
Receipts from sales of real estate and from miscellaneous sources which are placed to the credit of the North Metropolitan System: —		
For the year ending December 31, 1918,	$31 70	
For the period prior to January 1, 1918,	85,989 49	
		86,021 19
		$7,598,386 92
Amount approved for payment by the Board[1] out of the Metropolitan Sewerage Loan Fund, North System: —		
For the year ending December 31, 1918,	$35,738 27	
For the period prior to January 1, 1918,	7,293,288 27	
		7,329,026 54
Balance, North Metropolitan System, January 1, 1919,		$269,360 38

[1] The word "Board" refers to the Metropolitan Sewerage Commission and the Metropolitan Water and Sewerage Board.

South Metropolitan System.

Loans authorized under the various acts to January 1, 1919, applied to the construction of the Charles River valley sewer, Neponset valley sewer, High-level sewer and extensions, constituting the South Metropolitan System, . .			$9,587,046 27
Receipts from pumping, sales of real estate and from miscellaneous sources, which are placed to the credit of the South Metropolitan System: —			
For the year ending December 31, 1918, . .		$30 70	
For the period prior to January 1, 1918, . .		19,384 33	
			19,415 03
			$9,606,461 30
Amount approved by the Board for payment out of the Metropolitan Sewerage Loan Fund, South System: —			
On account of the Charles River valley sewer, .		$800,046 27	
On account of the Neponset valley sewer, . .		911,531 46	
On account of the High-level sewer and extensions, including Wellesley extension: —			
For the year ending December 31, 1918, ...	$115,596 89		
For the period prior to January 1, 1918, ...	7,652,149 90		
		7,767,746 79	
			9,479,324 52
Balance, South Metropolitan System, January 1, 1919, .			$127,136 78

(2) Total Sewerage Debt, December 31, 1918.

North Metropolitan System.

Bonds issued by the Treasurer of the Commonwealth: —		
Sinking fund bonds (3 and 3½ per cent.),		$6,563,000 00
Serial bonds (3½ and 4 per cent.),		925,500 00
Total bond issue to December 31, 1918,		$7,488,500 00
Serial bonds paid prior to January 1, 1918,	$75,000 00	
Serial bonds paid in 1918,	26,500 00	
		101,500 00
Total bond issue outstanding December 31, 1918,		$7,387,000 00
Gross Sewerage Debt,		$7,387,000 00
Sinking fund December 31, 1918,		2,690,491 90
Net Sewerage Debt December 31, 1918,		$4,696,508 10

A net decrease for the year of $241,826.02.

South Metropolitan System.

Bonds issued by the Treasurer of the Commonwealth: —		
Sinking fund bonds (3 and 3½ per cent.),		$8,877,912 00
Serial bonds (4 and 5 per cent.),		720,000 00
Total bond issue to December 31, 1918,		$9,597,912 00
Serial bonds paid prior to January 1, 1918,	$21,000 00	
Serial bonds paid in 1918,	21,000 00	
		42,000 00
Total bond issue outstanding December 31, 1918,		$9,555,912 00
Gross Sewerage Debt,		$9,555,912 00
Sinking fund December 31, 1918,		1,579,713 60
Net Sewerage Debt December 31, 1918,		$7,976,198 40

An increase for the year of $174,913.27.

(3) North and South Metropolitan Loan and Sinking Funds, December 31, 1918.

Year.	Loans.		Bonds issued (Sinking Fund).		Bonds issued (Serial Bonds).		Sinking Fund.
	North System.	South System.	North System.	South System.	North System.	South System.	North and South Systems.
1889, . .	$5,000,000 00	-	-	-	-	-	-
1890, . .	-	-	$2,200,000	$800,000	-	-	-
1891, . .	-	-	368,000	-	-	-	-
1892, . .	-	-	1,053,000	-	-	-	-
1893, . .	-	-	579,000	-	-	-	-
1894, . .	500,000 00	-	500,000	-	-	-	-
1895, . .	300,000 00	$500,000 00	300,000	300,000	-	-	-
1896, . .	30,000 00	-	30,000	200,000	-	-	-
1897, . .	85,000 00	300,000 00	80,000	300,000	-	-	-
1898, . .	215,000 00	35,000 00	220,000	35,000	-	-	-
1899, . .	-	4,625,000 00	-	1,025,000	-	-	$361,416 59
1900, . .	265,000 00	10,912 00[1]	265,000	10,912	-	-	454,520 57
1901, . .	-	40,000 00	-	2,040,000	-	-	545,668 26
1902, . .	-	-	-	864,000	-	-	636,084 04
1903, . .	500,000 00	1,000,000 00	500,000	1,736,000	-	-	754,690 41
1904, . .	-	392,000 00	-	392,000	-	-	878,557 12
1905, . .	-	-	-	-	-	-	1,008,724 95
1906, . .	55,000 00	1,175,000 00	55,000	175,000	-	-	1,146,998 68
1907, . .	-	-	-	300,000	-	-	1,306,850 30
1908, . .	413,000 00	-	-	700,000	-	-	1,492,418 98
1909, . .	-	-	300,000	-	-	-	1,673,784 40
1910, . .	56,000 00	-	113,000	-	-	-	1,931,741 89
1911, . .	6,000 00	-	-	-	-	-	2,184,674 98
1912, . .	378,000 00	-	-	-	$62,000	-	2,458,541 20
1913, . .	-	-	-	-	378,000	-	2,749,337 90
1914, . .	130,500 00	350,000 00	-	-	-	-	3,011,512 44
1915, . .	83,000 00	5,000 00	-	-	130,500	-	3,290,979 46
1916, . .	285,000 00	40,000 00	-	-	70,000	$355,000	3,604,657 27
1917, . .	-	325,000 00	-	-	285,000	40,000	3,925,792 75
1918, . .	-	-	-	-	-	325,000	4,270,205 50
	$8,301,500 00[2]	$8,797,912 00	-	-	-	-	-
	789,134 27	789,134 27	-	-	-	-	-
	$7,512,365 73	$9,587,046 27	$6,563,000	$8,877,912	$925,500	$720,000	-

[1] The sum of $10,912 was appropriated to reimburse the town of Watertown for the expense of constructing the Watertown siphon.

[2] Of this amount, $789,134.27 was expended for the construction of the Charles River valley sewer, which is now included in the South Metropolitan System.

(4) Annual Appropriations, Receipts and Expenditures.

The annual appropriations for the maintenance of the Metropolitan Sewerage Works, the receipts of the Board which are added to the appropriations for maintenance, and the expenditures for maintenance for the year ending December 31, 1918, were as follows: —

North Metropolitan System.

Appropriation as follows: —	
Chapter 67, Special Acts of 1918,	$235,700 00
Receipts from pumping and from other sources,	807 68
	$236,507 68
Amount approved by the Board for payment,	230,021 71
Balance January 1, 1919,	$6,485 97

South Metropolitan System.

Appropriation as follows: —	
Chapter 67, Special Acts of 1918,	$145,860 00
Receipts from pumping and from other sources,	10,763 65
	$156,623 65
Amount approved by the Board for payment,	155,874 58
Balance January 1, 1919,	$749 07

(5) Sewer Assessments, 1918.

The following sewer assessments were made by the Treasurer of the Commonwealth upon the various municipalities: —

North Metropolitan Sewerage System.

Sinking fund requirements,		$119,725 49
Serial bonds,		24,000 00
Interest,		231,648 74
Maintenance: —		
Appropriated by Legislature,	$235,700 00	
Less balance on hand,	14,946 02	
		220,753 98
Total North Metropolitan sewerage assessment,		$596,128 21

South Metropolitan Sewerage System.

Sinking fund requirements,		$74,272 86
Serial bonds,		20,902 50
Interest,		327,436 21
Maintenance: —		
Appropriated by Legislature,	$145,860 00	
Less balance on hand,	2,895 70	
		142,964 30
Total South Metropolitan sewerage assessment,		$565,575 87

In accordance with the provisions of chapter 369, Acts of 1906, the proportion to be paid by each city and town to meet the interest and sinking fund requirements for each year is based upon their respective taxable valuations, and to meet the cost of maintenance and operation upon their respective populations.

The divisions of the assessments for 1918 were as follows: —

North Metropolitan Sewerage System.

Cities and Towns.	Assessment.	Cities and Towns.	Assessment.
Arlington,	$17,349 75	Reading,[1]	$5,217 70
Belmont,	11,132 41	Revere,	23,540 26
Boston,	93,045 57	Somerville,	80,430 29
Cambridge,	127,065 18	Stoneham,	6,594 86
Chelsea,	35,579 26	Wakefield,	12,673 22
Everett,	34,676 69	Winchester,	15,802 33
Lexington,	5,946 00	Winthrop,	15,091 08
Malden,	46,453 57	Woburn,	15,558 85
Medford,	31,120 13	Total,	$596,128 21
Melrose,	18,851 06		

[1] Reading is also assessed $7,000 for sinking fund requirements in accordance with section 5, chapter 159, General Acts of 1916.

South Metropolitan Sewerage System.

Cities and Towns.	Assessment.	Cities and Towns.	Assessment.
Boston,	$257,203 09	Quincy,	$38,848 28
Brookline,	106,668 97	Waltham,	28,595 64
Dedham,	12,931 89	Watertown,	18,355 28
Milton,	23,456 65	Wellesley,[1]	11,833 12
Newton,	67,682 95	Total,	$565,575 87

[1] Wellesley is also assessed $6,775.23 for sinking fund requirements in accordance with section 5, chapter 343, Acts of 1914.

(6) Expenditures for the Different Works.

The following is a summary of the expenditures made in the various operations for the different works: —

Construction and Acquisition of Works.		For the Year ending December 31, 1918.	
North Metropolitan System.			
North System, enlargement: —			
Administration,		$2,606 01	
Deer Island Outfall extension,		7,437 56	
Removal of old Malden River siphon,		113 24	
Reading extension,		25,581 36	
			$35,738 17
Amount charged from beginning of work to January 1, 1918,			7,293,288 37
Total for North Metropolitan System to January 1, 1919,			$7,329,026 54
South Metropolitan System.			
High-level sewer extensions: —			
Administration,		$3,546 57	
Wellesley extension: —			
Section 98,	$75,014 94		
Section 99,	14,104 98		
Section 100,	408 93		
Section 101,	29 95		
Section 102,	14,025 41		
Section 103,	346 00		
Section 104,	315 53		
Section 105,	506 45		
Section 106,	943 80		
Real estate settlements,	4,330 00		
Legal, conveyancing and expert,	1,656 50		
Payments under Industrial Accident Law and special benefit appropriations,	96 00		
		111,778 49	
Additions to Ward Street pumping station plant,		271 83	
			$115,596 89
Amount charged from beginning of work to January 1, 1918,			9,363,727 63
Total for South Metropolitan System to January 1, 1919,			$9,479,324 52
Total for construction, both systems,			$16,808,351 06

Maintenance and Operation.	For the Year ending December 31, 1918.
North Metropolitan System,	$230,021 71
South Metropolitan System,	155,874 58
Total for maintenance, both systems,	$385,896 29

(7) Detailed Financial Statement.

The Board herewith presents, in accordance with the Metropolitan Sewerage acts, an abstract of the expenditures and disbursements, receipts, assets and liabilities for the year ending December 31, 1918: —

(a) *Expenditures and Disbursements.*

General Character of Expenditures.	For the Year ending December 31, 1918.	
Construction of Works and Acquisition by Purchase or Taking.		
North System Enlargement.		
Administration: —		
Commissioners,	$1,000 00	
Secretary,	300 00	
Clerks and stenographers,	795 58	
Stationery, printing and office supplies,	253 96	
Telephone, lighting, heating, water and care of building,	137 87	
Rent and taxes, main office,	107 10	
Miscellaneous expenses,	12 00	
		$2,606 01
Engineering: —		
Chief engineer,	$625 01	
Engineering assistants,	3,798 16	
Inspectors,	75 00	
Traveling expenses,	19 40	
Stationery, printing and office supplies,	1 97	
Telephone, lighting, heating, water and care of building,	412 29	
Rent and taxes,	321 30	
Miscellaneous expenses,	159 78	
		5,412 91
Brick, cement, lumber and other field supplies and expenses,	$151 26	
		151 26
Contracts: —		
Bruno & Petitti, Contract 144, for constructing a part of Section 76 of the Reading Extension of the North Metropolitan System,	$20,979 84	
Roy H. Beattie Inc., Contract 135, for constructing Section 1 of the Deer Island Outfall sewer extension in Boston Harbor,	6,581 09	
		27,560 93
Real estate: —		
Legal, conveyancing and expert,	$7 16	
		7 16
Total for North Metropolitan System,		$35,738 27

General Character of Expenditures.	For the Year ending December 31, 1918.	
South Metropolitan System.		
High-level Sewer Extensions.		
Administration: —		
Commissioners,	$1,333 33	
Secretary,	450 00	
Clerks and stenographers,	1,173 25	
Stationery, printing and office supplies,	268 36	
Telephone, lighting, heating, water and care of building,	156 61	
Repairs of building,	4 26	
Rent and taxes, main office,	152 96	
Miscellaneous expenses,	7 80	
		$3,546 57
Engineering: —		
Chief engineer,	$1,041 67	
Engineering assistants,	5,676 52	
Inspectors,	2,978 18	
Traveling expenses,	129 13	
Engineering and drafting instruments and tools,	24 92	
Stationery, printing and office supplies,	28 25	
Engineering and drafting supplies,	17 65	
Telephone, lighting, heating, water and care of building,	409 95	
Repairs of building,	12 79	
Rent and taxes, main office,	450 00	
Miscellaneous expenses,	458 82	
		11,306 88
Labor and teaming,	$1,414 72	
Tools, machinery and appliances,	273 24	
Brick, cement, lumber and other field supplies and expenses,	2,425 67	
		4,113 63
Contracts: —		
Bruno & Petitti, Contract 143, for constructing Section 102 of the High-level sewer (Wellesley extension) in Needham,	$11,784 73	
George M. Byrne, under agreement dated October 23, 1916, for constructing Section 98 of the High-level sewer (Wellesley extension) in West Roxbury and Dedham,	68,089 15	
George M. Bryne, under agreement dated October 6, 1917, for constructing Section 99 (in part) of the High-level sewer (Wellesley extension) in Dedham,	14 43	
Rowe Contracting Co., Contract 139, for constructing Section 99 (in part) of the High-level sewer (Wellesley extension) in Dedham,	10,659 00	
		$90,547 31
Payments under Industrial Accident Law and special benefit appropriations,	$96 00	
		96 00
Real estate: —		
Legal, conveyancing and expert,	$1,656 50	
Settlements,	4,330 00	
		5,986 50
Total for South Metropolitan System,		$115,596 89

General Character of Expenditures.	For the Year ending December 31, 1918.	
Maintenance and Operation of Works.		
North Metropolitan System.		
Administration: —		
Commissioners,	$2,333 34	
Secretary and assistants,	2,841 16	
Rent,	275 40	
Heating, lighting and care of building,	395 55	
Repairs of building,	2 44	
Postage,	60 00	
Printing, stationery and office supplies,	493 37	
Telephones,	45 92	
Miscellaneous expenses,	35 20	
		$6,482 38
General supervision: —		
Chief engineer and assistants,	$7,145 06	
Rent,	826 20	
Heating, lighting and care of building,	1,187 02	
Repairs of building,	7 31	
Printing, stationery and office supplies,	381 65	
Telephones,	137 78	
Traveling expenses,	75 00	
Miscellaneous expenses,	27 97	
		9,787 99
Deer Island pumping station: —		
Labor,	$22,383 93	
Fuel,	28,671 90	
Oil and waste,	158 41	
Water,	1,341 60	
Packing,	126 89	
Repairs and renewals,	801 29	
Telephones,	32 95	
General supplies,	739 47	
Miscellaneous supplies and expenses,	480 66	
		54,737 10
East Boston pumping station: —		
Labor,	$24,096 64	
Fuel,	31,619 00	
Oil and waste,	712 71	
Water,	1,786 03	
Packing,	192 28	
Repairs and renewals,	1,747 84	
Telephones,	4 05	
General supplies,	612 84	
Miscellaneous supplies and expenses,	513 16	
		61,284 55
Charlestown pumping station: —		
Labor,	$18,644 57	
Fuel,	10,444 21	
Oil and waste,	309 84	
Amounts carried forward,	$29,398 62	$132,292 02

General Character of Expenditures.	For the Year ending December 31, 1918.	
Amounts brought forward,	$29,398 62	$132,292 02
North Metropolitan System — Con.		
Charlestown pumping station — *Con.*		
Water,	643 30	
Packing,	78 89	
Repairs and renewals,	315 57	
Telephones,	51 53	
General supplies,	360 83	
Miscellaneous supplies and expenses,	195 90	
		31,044 59
Alewife Brook pumping station: —		
Labor,	$9,195 76	
Fuel,	4,718 57	
Oil and waste,	289 94	
Water,	229 44	
Packing,	33 72	
Repairs and renewals,	250 96	
Telephones,	40 00	
General supplies,	192 75	
Miscellaneous supplies and expenses,	46 01	
		14,946 15
Sewer lines, buildings and grounds: —		
Engineering assistants,	$2,141 67	
Labor,	33,102 75	
Automobiles,	221 56	
Brick, cement and lime,	478 27	
Castings, ironwork and metals,	956 58	
Freight, express and teaming,	18 39	
Fuel and lighting,	34 88	
Jobbing and repairing,	169 40	
Lumber,	1,509 42	
Machinery, tools and appliances,	567 70	
Paints and oils,	555 98	
Rubber and oiled goods,	91 60	
Sand, gravel and stone,	44 47	
Telephones,	60 12	
Traveling expenses,	955 79	
General supplies,	1,353 94	
Miscellaneous expenses,	421 39	
		42,663 81
Horses, vehicles and stable account,		5,973 14
Payments under Industrial Accident Law and special benefit appropriations,		3,083 00
Total for North Metropolitan System,		$230,021 71

General Character of Expenditures.	For the Year ending December 31, 1918.	
South Metropolitan System.		
Administration: —		
Commissioners,	$1,963 33	
Secretary and assistants,	1,911 25	
Rent,	198 90	
Heating, lighting and care of building,	227 81	
Repairs of building,	7 14	
Postage,	47 00	
Printing, stationery and office supplies,	350 63	
Telephones,	42 96	
Traveling expenses,	29 00	
Miscellaneous expenses,	35 83	
		$4,833 85
General supervision: —		
Chief engineer and assistants,	$4,772 28	
Rent,	596 70	
Heating, lighting and care of building,	683 56	
Repairs of building,	21 43	
Printing, stationery and office supplies,	117 21	
Telephones,	128 90	
Traveling expenses,	95 00	
Miscellaneous expenses,	55	
		6,415 63
Ward Street pumping station: —		
Labor,	$26,394 66	
Fuel,	36,499 36	
Oil and waste,	425 87	
Water,	1,585 20	
Packing,	650 17	
Repairs and renewals,	2,487 07	
Telephones,	40 10	
General supplies,	1,556 58	
Miscellaneous supplies and expenses,	1,136 17	
		70,775 18
Quincy pumping station: —		
Labor,	$9,707 87	
Fuel,	6,005 40	
Oil and waste,	96 62	
Water,	267 32	
Packing,	42 92	
Repairs and renewals,	109 09	
Telephones,	37 89	
General supplies,	426 13	
Miscellaneous supplies and expenses,	67 04	
		16,760 28
Nut Island screen-house: —		
Labor,	$9,404 50	
Fuel,	4,220 00	
Amounts carried forward,	$13,624 50	$98,784 94

General Character of Expenditures.	For the Year ending December 31, 1918.	
Amounts brought forward,	$13,624 50	$98,784 94
South Metropolitan System — Con.		
Nut Island screen-house — *Con.*		
Oil and waste,	146 49	
Water,	376 89	
Packing,	24 11	
Repairs and renewals,	353 82	
Telephones,	45 80	
General supplies,	556 71	
Miscellaneous supplies and expenses,	158 50	
		15,286 83
Sewer lines, buildings and grounds: —		
Engineering assistants,	$4,666 51	
Labor,	22,828 92	
Automobiles,	809 81	
Brick, cement and lime,	216 70	
Castings, ironwork and metals,	190 41	
Fuel and lighting,	47 24	
Freight, express and teaming,	4 53	
Jobbing and repairing,	905 20	
Lumber,	340 02	
Machinery, tools and appliances,	176 44	
Paints and oils,	258 96	
Rubber and oiled goods,	70 61	
Sand, gravel and stone,	196 56	
Telephones,	36 96	
Traveling expenses,	481 24	
General supplies,	429 12	
Miscellaneous expenses,	160 40	
		31,721 61
City of Boston, for pumping,		5,869 86
Horses, vehicles and stable account,		4,081 85
Payments under Industrial Accident Law and special benefit appropriations,		180 00
Total for South Metropolitan System,		$155,874 58

(b) *Receipts.*

The receipts from the sales of property, from rents and from other sources, have been credited as follows: —

Account.	For the Year ending December 31, 1918.
Construction: —	
North Metropolitan System,	$31 70
South Metropolitan System,	30 70
Maintenance: —	
North Metropolitan System,	807 68
South Metropolitan System,	10,763 65
Sinking fund: —	
North Metropolitan System,	166 63
South Metropolitan System,	8 33
Interest fund: —	
North Metropolitan System,	42 47
South Metropolitan System,	33 81
	$11,884 97
Amount credited from beginning of work to January 1, 1918,	138,778 80
Total receipts to January 1, 1919,	$150,663 77

(c) *Assets.*

The following is an abstract of the assets of the Sewerage Works, a complete schedule of which is kept on file in the office of the Board: —

Office furniture, fixtures and supplies; engineering and scientific instruments and supplies; horses, vehicles, field machinery, etc.; machinery, tools and other appliances and supplies; completed works, real estate connected therewith.

(d) *Liabilities.*

There are bills for current expenses which have not yet been received.

Amounts on Monthly Estimates, not due until Completion of Contracts or until Claims are settled.

Name.	Work.	Amount.
High-level sewer extensions: —		
Timothy J. O'Connell,	Contract 57, Section 82, in part,	$60 00
Rowe Contracting Co.,	Contract 139, Section 99 (in part), Wellesley Extension.	1,881 00

Settlements are pending with the following parties for easements taken in lands owned by them: —

F. Murray Forbes, Hugh D. Scott, Charles H. Harmon, Clifford M. Locke, Martha W. Burrage, Needham Tire Co., John Wells Farley, Edward and Catherine Bingham, Hannah Bingham, Katherine H. Rooney, Mary A. Read, Hannah E. Pond, Richard G. Wadsworth, John T. Morse, Jr., Frank D. Chase, Devisees of Anna E. Chase, Stephen M. Weld, Lucia Beebe, Edward F. Gilman, Herbert M. Hopkins, Joseph E. Hopkins, George A. Forbes, Bear Hill Associates.

VIII. RECOMMENDATIONS FOR LEGISLATION.

In the abstract of the annual report for the year 1918 the Board made the following statement and recommendations: —

In supplying the higher portions of Hyde Park and Milton it is necessary to use, in common with the Boston Water Department, a section of the pipe line about 2,200 feet in length located in Poplar Street in West Roxbury which belongs to the City of Boston. This has proved unsatisfactory at times and it is deemed necessary, in order to provide an adequate supply and to insure a reliable service for the Milton and Hyde Park extra high-service district, that a second pipe line should be laid in said street and under the Neponset River. The cost of this pipe line is estimated at $14,000.

When the northern extra high-service supply was introduced into Arlington in 1899 the town granted this Department the right to use, in common with the town, water pipes belonging to the town as far as necessary for the purpose of conveying water to the standpipe and to the town of Lexington. Satisfactory service is not now furnished by the use of the Arlington mains in common, and it is desirable to lay a 16-inch Metropolitan Water Works main from the Arlington standpipe to the Lexington boundary line, a distance of about 6,000 feet. The cost of this 16-inch main is estimated at $56,000.

The Legislature, by chapter 322 of the General Acts of 1917, authorized the construction of a new 36-inch water main about 1,800 feet in length in Chelsea to reinforce the East Boston supply main, and appropriated the sum of $30,000 for the work. Some expenses have been incurred chargeable to this appropriation but there is a balance remaining on hand of $29,820.86. It is estimated that, if this work is done in the coming year, the sum of $40,000 will be required, which will require an additional appropriation for this purpose of $11,000.

Attention has been called in all the reports of recent years to certain large expenditures in connection with some inevitable improvements and extensions of the metropolitan systems under the control of this Board. They are, fortunately, on the water supply system which yields a return more than sufficient to meet any expenditure which now seems requisite.

The plan submitted by the State Board of Health in 1895, and accepted by the Legislature of the same year, showed a direct line of communication between the proposed line to Weston and Spot Pond. As this connection could be avoided by pumping the Spot Pond supply from the Chestnut Hill reservoirs for a number of years, the Board has not hitherto brought the question before the Legislature, but it now seems advisable to give this plan serious attention. While it is quite true that there may be no interference with the operation of the pumps at Chestnut Hill, it is also true that the whole of the north system would be seriously impaired by their failure.

The direct connection between Weston and Spot Pond would remove the need of pumping the water supplied by the Weston system and would thus assure the maintenance of the Spot Pond reservoir under all conditions. Incidentally, this new line would afford a guarantee for the adequate supply of all the communities lying between Weston and Stoneham.

It is difficult to state the probable expense of this pipe line for two-thirds of the cost would be in the iron pipes and what that may be at the time when a contract might be made is uncertain. At present prices the pipe would cost approximately $1,200,000 and labor and the incidentals of the work $600,000.

The other proposed work is the replacement of the Arlington standpipe by a structure sufficient for the wants of this rapidly growing district which includes, in addition to Arlington, portions of Belmont and Lexington. The present standpipe was built by the town for its own use without reference to any requirements beyond the limits of the town and has become inadequate. It is proposed to replace this structure by one similar to that erected on Mt. Bellevue in West Roxbury for the southern extra high-service district. The estimates for this are, — for the tank, $65,000, and for masonry, $110,000. With the exception of the steel plates the work of building the tank and the masonry would be performed in this State by men employed here.

By chapter 343 of the Acts of 1914 the construction of the Wellesley Extension of the South Metropolitan Sewer was authorized and the sum of $350,000 appropriated for the work. On account of the bad material encountered and the abnormal condition of the market in regard to labor and supplies this sum was found to be inadequate and on calling the attention of the Legislature to the situation a further appropriation of $325,000 was authorized under the provisions of chapter 285 of the General Acts of 1917. Since the last-named appropriation was made there has been a still further substantial increase in the cost of labor and materials and some large claims for land damages have been presented which the Board has not felt justified in paying and upon which suits have been brought. It is estimated that the total cost to complete the work will be about $340,000, exclusive of land damages and engineering expenses. There is a balance on hand from previous appropriations of $125,000. The Board, therefore, recommends a further appropriation of $225,000 and believes this amount will be sufficient to complete the work.

The Legislature admitted the town of Reading to the North Metropolitan Sewerage System by chapter 159 of the General Acts of 1916 and appropriated $285,000 for the purpose of connecting the town with this system. All the

estimates made since that date show that the expense of constructing the sewer will very largely exceed the amount of the appropriation. An estimate made by a responsible contractor a year ago amounted to $700,000. Whether conditions will be such as to make it probable that any reduction in this amount can now be expected is a matter upon which the Board is unable to give a satisfactory answer. For the completion of this work the Board recommends an additional appropriation of $415,000.

The detailed reports of the Chief Engineer of Water Works and of the Chief Engineer of Sewerage Works, with various tables and statistics, are herewith presented.

Respectfully submitted,

HENRY P. WALCOTT,
EDWARD A. McLAUGHLIN,
JAMES A. BAILEY,
Metropolitan Water and Sewerage Board.

BOSTON, February 26, 1919.

REPORT OF CHIEF ENGINEER OF WATER WORKS.

To the Metropolitan Water and Sewerage Board.

GENTLEMEN: — I have the honor to submit a report of the work done in connection with the construction, maintenance and operation of the Metropolitan Water Works for the calendar year 1918.

ORGANIZATION.

The organization of the force employed under the direction of the Chief Engineer has remained the same as in 1917. The principal assistants are as follows: —

John L. Howard, . . .	Assistant to Chief Engineer.
Elliot R. B. Allardice, . .	Superintendent of Wachusett Department.
Charles E. Haberstroh, . .	Superintendent of Sudbury Department.
Samuel E. Killam, . . .	Superintendent of Distribution Pipe Lines and Reservoirs.
Arthur E. O'Neil, . . .	Superintendent of Distribution Pumping Stations.
Alfred O. Doane, . . .	Division Engineer, in charge of Mechanical Engineering and Inspection Work.
William W. Locke, . . .	Sanitary Inspector, in charge of Sanitary Inspection of Watersheds.
Clifford Foss, ...	Assistant Engineer, in charge of Distribution Civil Engineering.
Benjamin F. Hancox, . .	Head Draftsman, in charge of Drafting Force.
James W. Killam, . . .	Assistant Engineer, in charge of Coal and Oil Laboratory and compilation of Pumping Statistics.
William E. Whittaker, . .	Office Assistant, in charge of General Office and compilation of Water Supply Statistics.
Charles E. Livermore, . .	Biologist, in charge of Microscopical and Bacteriological Examinations of the Water Supply.

Including these principal assistants the number of supervising, engineering and clerical employees was 39 at the beginning of the year and 42 at the end of the year.

In addition to the office forces the labor forces engaged in maintaining and operating the reservoirs, aqueducts, pipe lines, hydroelectric stations and pumping stations and doing minor construction work have been as follows: —

Department.	Beginning of Year.	End of Year.	Maximum.	Average.
Wachusett,	49	41	65	50
Sudbury,	82	62	91	82
Distribution, pipe lines and reservoirs,	91	82	102	88
Distribution, pumping service,	61	70	71	65
	283	255	329	285

During the year 18 employees were mustered into the United States service.

CONSTRUCTION.

Deferred Projects.

On account of the continued high prices of labor and materials work was not undertaken on the improvement of Beaver Dam Brook, which was authorized in 1913; on the 12-inch southern extra high-service pipe line and the 16-inch northern extra high-service pipe line, which were authorized in 1916, and on the 36-inch low-service pipe line that was authorized in 1917, as the appropriations for these projects were not sufficient to cover the cost of the work under the abnormal conditions due to the war.

Wachusett–Sudbury Transmission Line.

The Wachusett–Sudbury high-tension power transmission line, which extends for a distance of 15.59 miles over Water Works lands from the New England Power Company's high-tension line at a point near the Wachusett Dam in Clinton to the proposed out-door transformer station, which is being constructed by the Edison Electric Illuminating Company of Boston at the Sudbury Dam in Southborough, is designed for 66,000-volt service and has been constructed in order to dispose of the entire output from the Wachusett power station for a period of ten years. Details of construction of the line were fully described in my last annual report.

The contract work remaining to be done at the close of the year 1917 included some field riveting of the steel towers, the placing of

Special Double-pole Structure on Wachusett-Sudbury Power Transmission Line at the Lower Dam of the Wachusett Aqueduct in Southborough

the insulators, the stringing of the power and telephone conductors and the final painting of the poles and towers.

The riveting of the towers was completed January 10 and work was then suspended until April 22 when it was resumed and prosecuted continuously with a small force until completed on July 3.

The private telephone line which was constructed in connection with the power line was completed by the department forces, the connections being made into the power stations through underground conduits. Telephone instruments were installed at the power station and the storage yard in Clinton and at the tool-house near the terminal chamber of the Wachusett Aqueduct in Marlborough, and at the Sudbury power station in Southborough. The telephone line was put into service on August 3.

The switchboard at the Sudbury power station has been rewired so that the spare 15,000-volt underground cable can be connected with the new transmission line while the other remains connected with the Hopkinton line.

The structures along the power line have been numbered consecutively from the Clinton to the Southborough ends of the line and the towers have been marked with enameled iron and the poles with aluminum danger tags.

As there appeared to be no prospect of the Edison Electric Illuminating Company completing its connecting line until the following year, the Wachusett–Sudbury line was temporarily grounded at four points after completion to protect it from lightning.

At midnight December 31 the maintenance of the transmission line was turned over to the electric companies, according to the provisions of the contract for the sale of the electric energy generated at the Wachusett power station, which is to be in force for a period of ten years from said date.

The cost of the transmission line, exclusive of administration and the clearing of the location, which was done by the regular maintenance force, is as follows: —

Contract for constructing line and furnishing all materials except 200 poles,	$74,875 14
Cutting and delivering 200 poles,	1,527 76
Extension of telephone line to power stations, etc.,	1,217 06
Real estate and conveyancing,	805 84
Engineering,	3,351 72
	$81,777 52

Additional Northern Extra High-service Pumping Machinery.

At the northern extra high-service pumping station in Arlington the work of installing the steam turbine driven centrifugal pumping unit of a capacity of 3,000,000 gallons in 24 hours and the horizontal return tubular boiler 54 inches in diameter by 17 feet in length has been completed and the coal pocket has been extended to obtain increased storage capacity.

The pumping unit was first operated on April 8 and the official duty trials made on May 7, 8 and 9. The unit consists of a Moore multi-stage condensing steam turbine of 260 brake horse power rating at 125 pounds steam pressure, connected through speed reducing gears with two Allis-Chalmers single-stage 8-inch centrifugal pumps in series. The nominal speed of the turbine is 5,000 revolutions per minute for the rated capacity of 3,000,000 gallons in 24 hours against a head of 320 feet.

The condensing equipment, which was built by the Wheeler Condensing & Engineering Company, consists of a surface condenser of the water works type, with a cooling surface of 600 square feet, and an independent air pump of the crank and fly-wheel type.

The results of the official duty trials, which were of eight hours' duration, at one-third, two-thirds, and full capacity are as follows: —

	One-third Capacity.	Two-thirds Capacity.	Full Capacity.
Average pressures: —			
Atmospheric (pounds per square inch),	14.580	14.475	14.628
Steam, absolute (pounds per square inch),	140.460	140.085	140.078
Vacuum (inches of mercury of standard density),	28.432	28.288	28.332
Absolute in condenser (pounds per square inch),	0.617	0.582	0.668
Average temperatures: —			
Air in engine-room (degrees Fahrenheit),	92.60	84.59	79.76
Air in basement (degrees Fahrenheit),	80.00	75.38	72.59
Air outside station (degrees Fahrenheit),	91.40	75.59	67.18
Water pumped: —			
At condenser inlet (degrees Fahrenheit),	56.10	61.00	64.53
At condenser outlet (degrees Fahrenheit),	59.50	63.00	67.18
Work done: —			
Average discharge head (feet),	433.64	453.80	461.00
Average suction head (feet),	153.88	153.41	140.04
Average head pumped against (feet),	279.76	300.39	320.96

	One-third Capacity.	Two-thirds Capacity.	Full Capacity.
Work done — *Con.*			
Water pumped: —			
Total in 8 hours (by Venturi meter, gallons),	351,100	673,600	1,013,700
Total weight (computed, pounds),	2,927,305	5,614,360	8,445,240
Average rate per 24 hours (gallons),	1,053,300	2,020,800	3,041,100
Average speed of pumps (observed revolutions per minute),	1,455	1,526	1,655
Work done during 8-hour trial (foot-pounds),	818,942,600	1,686,491,000	2,710,580,000
Steam used: —			
By turbine (pounds),	14,269.400[1]	20,593.000[2]	29,635.000[3]
By air pump (pounds),	484.500	479.700	494.250
Total (pounds),	14,753.900	21,072.700	30,129.250
Average moisture (per cent.),	1.736	1.236	4.637
Heat used: —			
By turbine (B. T. U.),	16,024,650	23,252,200	32,431,180
By air pump (B. T. U.),	483,390	480,818	480,555
Total (B. T. U.),	16,508,040	23,733,018	32,911,735
Duties: —			
Per 1,000,000 British thermal units (contract basis, foot-pounds).	49,608,700	71,061,200	82,359,200
Per 1,000 pounds of moist steam (foot-pounds),	55,506,900	80,032,277	89,965,200

[1] Including 10.4 pounds for steam seal at turbine shaft.
[2] Including 20 pounds for steam seal at turbine shaft.
[3] Including 11 pounds for steam seal at turbine shaft.

Summary of Results.

		Foot-pounds per Million British Thermal Units.
One-third capacity duty,		49,608,700
Two-thirds capacity duty,		71,061,200
Full capacity duty,		82,359,200
Average duty,		67,676,400
Average duty guaranteed,		60,000,000
Excess duty above guarantee,		7,676,400
Additional compensation for excess duty provided by contract,	$700.00	

The new horizontal return tubular boiler is 54 inches in diameter and contains 60 charcoal iron tubes 3 inches in diameter and 17 feet long, and a working steam pressure of 160 pounds per square inch is allowed. The boiler was delivered at the pumping station

March 18 and is set in battery with the two similar boilers which were installed when the station was built in 1907. The brick setting for the boiler was built by the department forces and was completed June 29.

Two Coppus blowers, one 12 inches and the other 14 inches in diameter, were installed so that forced draft can be used with any of the boilers. The grate is 4 feet wide x 5 feet 6 inches long, with ¼-inch air spaces, and was made by the New England Roller Grate Company.

A second line of main steam pipe, most of it 4 inches in diameter, was installed and connected with all of the boilers and engines. The steam piping is now arranged so that any one or all of the engines can be supplied with steam through either or both steam pipes.

A 3-inch Cochrane separator was installed at the throttle valve of the new engine and a No. 9 Whitlock coil heater is connected with the exhaust pipe of the air pump to heat the boiler feed water.

The coal pocket extension is 31½ feet long x 28 feet wide x 9½ feet high, and equivalent in size to the old pocket, so that the storage capacity has been doubled. The pocket is constructed of concrete masonry, except the exposed exterior, which is of Weymouth seam face and Deer Isle granites to match the lower portion of the pumping station. The pocket is located under the existing side-track and coal can be dumped into it directly from the cars through hatches in the roof. The construction of the new pocket was begun April 4 and was practically completed at the close of the year. Most of the work was done by the department forces.

The cost of the improvements at the pumping station, exclusive of administration, is as follows: —

Engine,	$9,700 00
Engine foundation and additional work,	561 52
Boiler,	2,324 51
Boiler setting and additional work,	1,984 70
Coal pocket excavation and concrete walls and roof,	5,211 03
Coal pocket, granite facing,	1,739 00
Piping,	2,628 40
Miscellaneous work,	1,525 98
Engineering,	2,240 40
	$27,915 54

Duplicate Southern Extra High-service Pipe Line under Neponset River in Hyde Park.

A contract was made with the United States Cast Iron Pipe & Foundry Company on June 26, 1918, for furnishing 12-inch flexible jointed pipes for the southern extra high-service line under the Neponset River at West Street in Hyde Park, which was authorized in 1916. On account of delay in delivery the pipes were not received until November 23, and as the weather was then unfavorable for laying the pipe the work was postponed and will not be undertaken until the weather is favorable in the spring of 1919. The pipe line will be about 365 feet in length.

Additional 20-inch Pipe Line for Watertown and Belmont.

On account of the large increase in the quantity of water used in Watertown, due to the greatly increased activity at the United States Arsenal and at several factories in the vicinity, it became necessary to construct an additional supply main in order to maintain satisfactory service in Watertown and Belmont.

The new main was authorized April 26 by chapter 177 of the General Acts of 1918. It extends from the 36-inch southern high-service main through Commonwealth Avenue, Newton, to Lake Street, and thence through Lake Street, private land, Fairbanks Street and Brooks Street in Brighton, to and across the North Beacon Street bridge into Watertown.

The pipe line is 20 inches in diameter for a distance of 9,664 feet and is reduced to 16 inches in diameter for a distance of 503 feet to cross the bridge in the limited space available.

Contract for the pipes was made with the United States Cast Iron Pipe & Foundry Company on May 1, 1918, and the contract for laying the pipes was made with Michele DeSisto May 29. Pipe laying was begun June 3 and was continued at the specified rate until September 7. Work was then suspended until September 30 on account of delay in receiving pipes from the foundry. Pipe laying was completed October 18 and the contract work was entirely completed on October 28. The average force employed on pipe laying was 32 men and 4 horses.

Following the practice begun in 1909, insulating joints were installed in the pipe line about 500 feet apart to reduce the damage to

the distribution pipes by electrolytic action produced by the underground electric currents from the street railways.

The pipe line was filled with water and tested by the department forces, and after draining and refilling was put into service November 7. The resulting increase of pressure was 25 pounds per square inch at the Arsenal, 15 pounds per square inch at Watertown Town Hall and about 12 pounds per square inch in Belmont.

The cost of the work, exclusive of administration, is as follows: —

Pipes and special castings,	$56,351 37
Laying pipe,	31,330 21
Municipal work on underground structures and resurfacing streets,	3,403 58
Work done by department force installing wooden joints and air valves, testing and filling pipe line and miscellaneous work,	986 74
Engineering and preliminary,	4,725 10
Real estate and conveyancing,	1,323 75
	$98,120 75

MAINTENANCE.

Rainfall and Yield of Watersheds.

The annual precipitation was below the average on all of the watersheds, being 39.77 inches on the Wachusett watershed as compared with an average of 44.68 inches and a minimum of 37.26 inches for the past twenty-two years; 40.54 inches on the Sudbury watershed as compared with an average of 44.51 inches and a minimum of 32.78 inches for the past forty-four years; and 39.04 inches on the Cochituate watershed as compared with an average of 45.12 inches and a minimum of 31.20 inches for the past fifty-six years.

The monthly precipitation on the Wachusett watershed was below the average except in February, June and September, and on the Sudbury watershed it was below the average except in April, June, July and September. The large precipitation of September, amounting to 7.18 inches on the Wachusett watershed and to 8.60 inches on the Sudbury watershed, and the small precipitation in May and October are noticeable variations from the normal monthly precipitation.

The monthly yield from the Wachusett watershed was below the average for the past twenty-two years, except in February, March and September. The yield for the year was 902,000 gallons per day per square mile, which is 85.5 per cent. of the average for the past twenty-two years. The minimum annual yield during this period was 682,000 and the maximum 1,551,000 gallons per day per square mile. The yield from the Sudbury watershed was 736,000 gallons

per day per square mile, which is 75.49 per cent. of the average for the past forty-four years. The minimum annual yield during this period was 514,000 and the maximum 1,697,000 gallons per day per square mile. The yield of the Cochituate watershed was 758,000 gallons per day per square mile, which is 82.75 per cent. of the average yield for the past fifty-six years. The minimum annual yield during this period was 465,000 and the maximum 1,510,000 gallons per day per square mile.

During March and April the city of Worcester turned 583,400,000 gallons of water into the Wachusett watershed from the 9.35 square miles formerly in the Wachusett Reservoir watershed which it took for its water supply in 1911, and by agreement the city is entitled to compensation from the Commonwealth for this water as the Wachusett Reservoir did not fill during the year.

Storage Reservoirs.

The capacities of the storage reservoirs of the Metropolitan Water Works, the elevation of the water surfaces and the quantity of water stored in each reservoir at the beginning and at the end of the year are shown by the following table: —

Storage Reservoirs.	Elevation[1] of High Water.	Capacity (Gallons).	Jan. 1, 1918.		Jan. 1, 1919.	
			Elevation[1] of Water Surface.	Amount stored (Gallons).	Elevation[1] of Water Surface.	Amount stored (Gallons).
Cochituate watershed: —						
Lake Cochituate,[2] . .	144.36	2,097,100,000	141.91	1,524,600,000	142.91	1,755,400,000
Sudbury watershed: —						
Sudbury Reservoir, .	260.00	7,253,500,000	257.52	6,225,200,000	258.24	6,520,600,000
Framingham Reservoir No. 1.	169.32	289,900,000[3]	167.71	216,500,000	167.87	223,400,000
Framingham Reservoir No. 2.	177.87	529,900,000[3]	176.02	482,600,000	176.20	490,300,000
Framingham Reservoir No. 3.	186.74	1,180,000,000[3]	183.25	920,300,000	185.09	1,066,200,000
Ashland Reservoir, .	225.21	1,416,400,000	223.59	1,327,900,000	224.50	1,377,300,000
Hopkinton Reservoir, .	305.00	1,520,900,000	303.30	1,415,100,000	304.18	1,469,600,000
Whitehall Reservoir, .	337.91	1,256,900,000	336.79	1,040,000,000	336.90	1,061,100,000
Farm Pond, . . .	159.25	167,500,000	157.75	88,200,000	158.12	107,500,000
Wachusett watershed: —						
Wachusett Reservoir, .	395.00	64,968,000,000	385.94	53,225,600,000	381.88	48,426,600,000
Totals, ...	-	80,680,100,000	-	66,466,000,000	-	62,498,000,000

[1] Elevation in feet above Boston City Base.
[2] Excluding Dudley Pond which was abandoned April 3, 1916.
[3] To top of flash-boards.

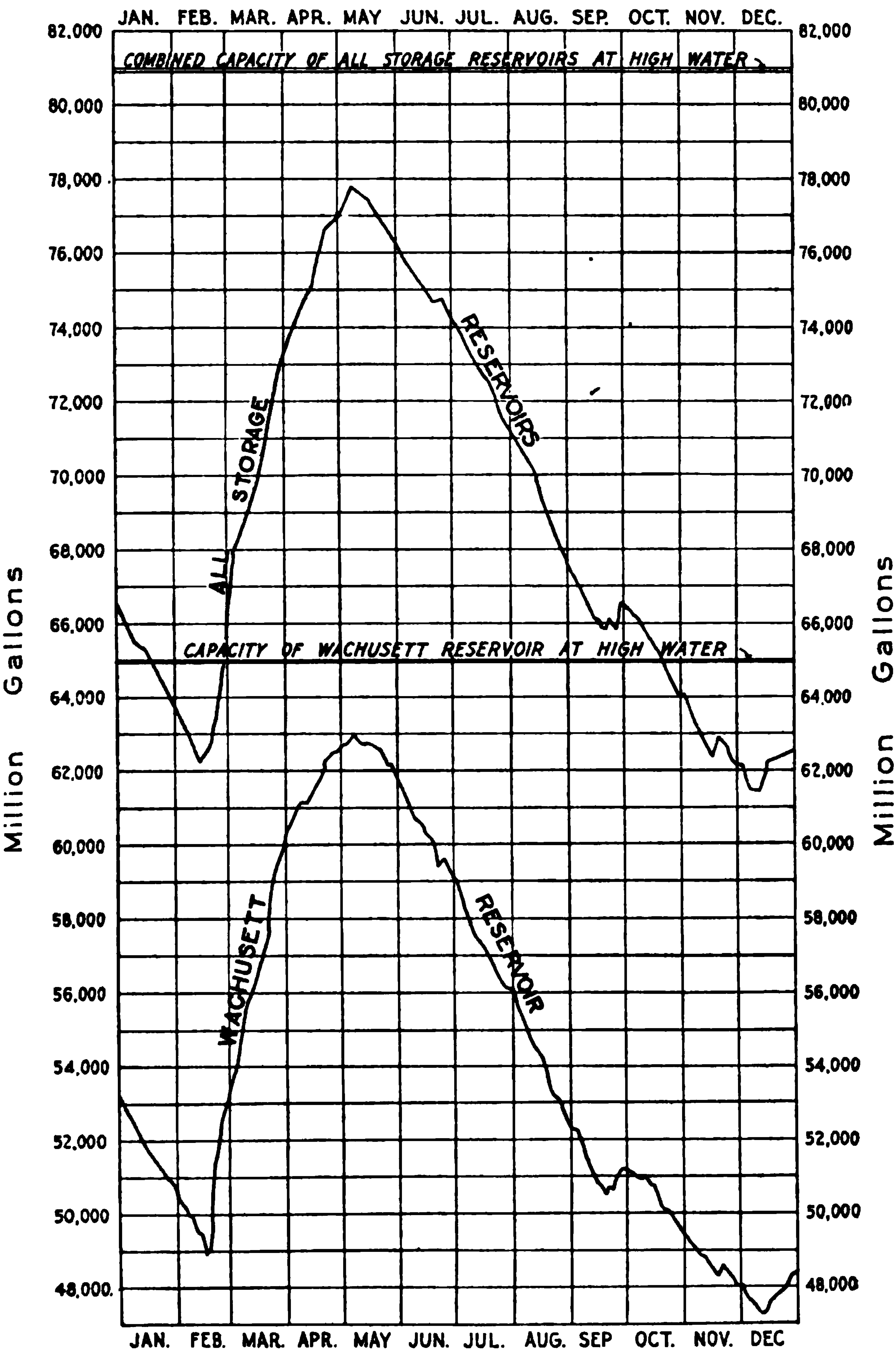
The diagram on page 57 shows the quantity of water stored in the Wachusett Reservoir and the quantity stored in all the storage reservoirs combined during the year.

The table and diagram show the total storage which could be drained from the reservoirs. Special provisions would be necessary, however, to draw about 10,000,000,000 gallons of this storage for consumption as it is below the outlet channels which can be conveniently used for regular service.

Wachusett Reservoir. — At the beginning of the year the Wachusett Reservoir contained 53,225,600,000 gallons of water and the surface of the water was at elevation 385.94, approximately 9 feet below high-water line. On account of the large consumption, due to the extremely cold weather, the water was drawn down rapidly and stood at elevation 382.29 on February 16. With the spring rains and thaws the water rose rapidly until May 6 when it was at elevation 393.50, which was the highest point reached during the year, and 1½ feet below high-water mark. The reservoir then contained 62,959,000,000 gallons of water, which subsided under the constant draft for water supply at a rate of about 2½ feet per month until September 16. On account of the heavy precipitation the water in the reservoir remained at a nearly constant level during the following month and then subsided at a nearly uniform rate until December 13, when it stood at elevation 380.77, which was the lowest point reached during the year and the reservoir then contained 47,171,200,000 gallons of water. From December 13 to the end of the year the water rose gradually to elevation 381.88 and the reservoir then contained 48,426,600,000 gallons of water.

During the year 1,087,200,000 gallons of water was discharged from the reservoir through the pool below the dam and through the pipe line to the Lancaster Mills, in accordance with the provisions of section 4 of chapter 488 of the Acts of the year 1895, which requires that not less than 12,000,000 gallons, and such further quantity not exceeding 12,000,000 gallons as the owners of the mills shall deem necessary, shall be allowed to flow from the reservoir during each week. The amount of water furnished to the mills is 211,400,000 gallons less than during the previous year. This reduction was brought about by notifying the mill officials that their requirements were at times in excess of the amount provided by statute and, as a result, in September they made extensive repairs and alterations in

QUANTITY OF WATER STORED IN THE WACHUSETT RESERVOIR AND IN ALL THE STORAGE RESERVOIRS COMBINED DURING 1918



their canal which stopped a large amount of leakage, and the saving for an entire year should be about 625,000,000 gallons.

During March and April the emergency pumping station of the city of Worcester, located on the shore of the reservoir at south bay in Boylston, which was erected in 1911, was dismantled and removed by city employees. The foundations and intake pipes were allowed to remain for the present. The station was used on 15 days during January, 1915, which is the only use made of it since November 10, 1911, when the emergency for which it was constructed ended.

Miscellaneous débris brought into the upper basins of the reservoir during the high water flow in the spring was collected and disposed of at a cost of $128.51. Brush and weeds were mowed, raked into piles and burned along the sides of the highways adjoining water works lands, along the brooks flowing directly into the reservoir, along a portion of the margin of the reservoir and at the North and South dikes. This work extended over a distance of about 37 miles and cost $1,706.10.

The 10-ton motor scow used in connection with the work around the reservoir, for the transportation of men, horses and materials, was in use from the spring until the late fall. Before placing the scow in service it was necessary to make extensive repairs as the seams had opened to such an extent that the calking would not hold. It was necessary to fit narrow strips of thin white pine over the seams and fasten them to the planking with brass wood-screws; the joints were then made up with "Sealtite," a plastic asphaltum and asbestos cement. The scow was then painted inside and outside. The cost of the work was $151.59.

The Wachusett Dam is in good condition, with the exception of the granolithic walk across the top. The planking in the bridge at the waste-weir and the roofs of the gate-chamber and the power station require extensive repairs. Temporary repairs have been made to the roof of the power station in order to protect the machinery until permanent repairs are made. A large tar-paper-lined wooden drip-pan about 14 feet x 26 feet was placed in the loft of the station about a foot beneath the upper side of the roof and directly over the switchboard and the controlling electrical apparatus arranged so as to catch the water as it drips through the roof and conduct it to the leaders at the eaves.

The iron, picket and rail fences about the dam, waste-weir and

waste channel and the iron flash-board standards and bridge supports on the waste-weir have been painted one coat of Smith's Durable Metal Coating.

The exterior and interior woodwork of the garage and the exterior woodwork of the power station have been painted.

On account of the scarcity of labor an Ideal power lawn mower, fitted with a heavy lawn roller, was purchased early in June for use in connection with the care of the lawns about the dam, and has given entire satisfaction.

The tenements on the reservoir lands and the buildings at the Clinton and Oakdale storage yards have been given such attention as was necessary to keep them in good condition. At the Kramer house, near the Wachusett Dam, Clinton, the cellar walls were reinforced with concrete footings to keep out drainage and rats, at a cost of $62.40. At the Cook place, Lancaster Street, West Boylston, the exterior of the house, barn and garage were given two coats of paint; a new cesspool was constructed and plumbing and drains remodeled, and the barn cellar was prepared for storage purposes. The cost of this work was $494.03. At the Kendall place, Main Street, Boylston, the work of razing the large barn, repairing the other buildings and improving the grounds, which was begun in 1917, was completed at a cost of $992.35.

Standing grass was sold at auction from about 350 acres of water works land bordering on the reservoir and tributary streams. The total receipts from the sale amounted to $1,386.75.

Sudbury Reservoir. — The water in the Sudbury Reservoir was at elevation 257.52, approximately 1½ feet below the crest of the overflow, at the beginning of the year and was kept at least one foot below the crest until the flash-boards were put in place April 9, and was not then allowed to rise above the crest of the overflow until July. It then fluctuated above and below the crest until the flash-boards were removed on November 18. The water was then kept at about elevation 258.00 until the end of the year.

The usual attention has been given to the care of the reservoir lands and structures. The shores of the reservoir were cleaned and the débris which had collected in the coves was removed. Gravel was screened and placed on the driveways, the walks at the dam were weeded and loam was spread on the outer slope of the dam embankment. The shrubs at the entrance to the driveway were

pruned as usual and, together with the apple trees at the northerly end of the dam, were sprayed with Scalecide to protect them from insects. A channel was cut in the ice back of the overflow at the dam and was kept open during the cold weather to protect it from ice pressure. Snow was removed from the sidewalks adjacent to the water works land on Maple Street in Marlborough, and from the walks and steps at the Sudbury Dam. The flash-boards and standards on the overflow of the dam, the ironwork of the interior and exterior of the meter chamber, including the meter registers, and the iron railings of the bridge over the open channel below the dam were painted and part of the stone coping of the bridge which had settled was reset to grade. Minor repairs were made to the house and barn at the dam. The sprouts and brush were mowed in the 5-foot lanes along the land lines for a distance of 3.25 miles at a cost of $36.

Framingham Reservoir No. 3. — All the water delivered through the Sudbury Aqueduct for the supply of the Metropolitan Water District was drawn from Framingham Reservoir No. 3, which was replenished with water from the Sudbury Reservoir as required. During the winter the water was kept below the crest of the overflow, between elevations 182 and 185, and during the warm weather the water was kept near the crest, between elevations 183 and 186. The flash-boards were kept on the overflow throughout the year and no water was wasted from the reservoir either through the gates or over the flash-boards. Sprouts and brush were mowed in the 5-foot lanes along property lines for a distance of 2½ miles, and brush which was growing at various points along the shores of the reservoir was mowed and the embankments and gate-houses were given the usual care.

Framingham Reservoirs Nos. 1 and 2, Ashland, Hopkinton and Whitehall Reservoirs. — No water was drawn from these reservoirs for supplying the Metropolitan Water District during the year. During the winter and early spring the flash-boards were removed from the crests of the dams, except at Whitehall Reservoir which has no overflow. Water was wasted, when necessary to maintain the desired elevation, over the crests of the dams except at Whitehall Reservoir where it was wasted through the gates. The water was lowered somewhat in all of these reservoirs, except in Framingham Reservoir No. 1, during the early spring by wasting through the

gates so that the freshet flows could be controlled properly. During the remainder of the year, when the flash-boards were in position, if the waste could not be easily regulated by the removal or replacement of a few flash-boards, the water was wasted through the gates when necessary to prevent the reservoirs from filling above the desired elevation.

A discharge of not less than 1,500,000 gallons of water per day was maintained throughout the year from Framingham Reservoir No. 1 into the Sudbury River, as required by the provisions of chapter 177 of the Acts of the year 1872. Water was also discharged in larger quantities from time to time, as required, to dispose of a portion of the yield of the watershed above Dam No. 1 which could not be stored in the reservoirs.

The usual attention was given to the dams, gate-houses and structures at these reservoirs.

A new fence, consisting of two rails 2 inches x 6 inches supported by wooden posts, was built along both sides of Fountain Street where it passes through Framingham Reservoir No. 2 and within the limits which we are required by agreement with the town of Framingham to keep in repair. The total length of fence built was 2,088 feet. It was given two coats of paint. The cost of the work was $375 for labor and $408.15 for materials.

At the Ashland Reservoir the new barn 30 feet x 30 feet in plan for the use of the gate-keeper, the construction of which was begun last year, was completed. Provision has been made for storing hay and housing wood and teams, and stalls have been constructed for two cows and a horse. The building takes the place of three old buildings which were torn down. The appearance of the grounds has been greatly improved by the removal of the old buildings and the grading of the grounds around the new barn and the extension of the driveway. A trellis for climbing vines and a lattice were constructed to screen the clothes yard and outbuildings. All of this work was done by the regular department force.

Brush was mowed and burned along the waste channel below the dam. Sprouts and brush were mowed in the 5-foot lanes along property lines for a distance of 4.4 miles.

At the Hopkinton Reservoir the upper portion of the chimney in the gate-keeper's house at the dam was taken down and rebuilt to remove an offset which caused creosote from the burning wood to

ooze through the chimney and stain the paper and plastering in some of the rooms.

Brush was mowed and burned along the waste channel below the dam, and sprouts and brush were mowed in the 5-foot lanes along property lines for a distance of 6.5 miles.

At Whitehall Reservoir brush was mowed and burned in the 5-foot lanes along property lines for a distance of 5.7 miles. One cottage was built at this reservoir by an adjoining property owner and there are now 65 cottages located on the shores of the reservoir. There were 8 motor boats, 92 row boats and 26 canoes in use on the reservoir during the summer, a total of 126, which is 9 more than in 1917.

Brush was mowed and burned in the 5-foot lanes along property lines for a distance of 19.5 miles in Cedar Swamp and along the Sudbury River just below the Rocklawn Mills.

Farm Pond. — Although Farm Pond is not used as a source of supply for the Metropolitan Water District the water therein has been kept within about one foot of high-water line throughout the year by supplying it with water from Framingham Reservoirs Nos. 1 and 2 on June 26, to accommodate the town of Framingham, which obtains a portion of its water supply from the filter-gallery located on the easterly shore of the pond. No water was wasted from the pond during the year. Under the rights reserved by legislation the town of Framingham pumped 196,600,000 gallons of water from the filter-gallery and the Boston & Albany Railroad took approximately 77,300,000 gallons and the New York, New Haven & Hartford Railroad took approximately 71,500,000 gallons directly from the pond for use during the year.

Lake Cochituate. — At the beginning of the year the water in Lake Cochituate was at elevation 141.57, approximately 2¾ feet below high-water line. Water was drawn from the lake through the Cochituate Aqueduct for consumption in January and February and was wasted at the outlet dam during every other month in the year to maintain the desired elevation.

Minor repairs and improvements were made in the drains at the foreman's house and at the barn and shop and carriage and tool sheds. The iron and wood work in the effluent gate-house were given two coats of paint and the tin roof one coat. The shop, wagon-shed, doors and window frames of the barn were given two coats of paint.

During the year the débris which collected in the coves around the lake was removed. The grass and brush on both sides of the open channel portion of the surface water drain from Cochituate Village was mowed for a width of 10 feet and sediment was removed from the catch basins, open channel and sand catcher at Bannister's Brook. Brush was mowed in the 5-foot lanes along property lines for a distance of 6 miles.

During the year ten cottages were built by adjoining property owners and one cottage was burned. There are now one hundred and thirty-three cottages, fifteen garages and one stable on the adjoining lands.

Aqueducts.

Wachusett Aqueduct. — Water was discharged through the Wachusett Aqueduct from the Wachusett Reservoir on 298 days. The total time that the aqueduct was in use is equivalent to 126 days, 2 hours and 4 minutes. The total quantity of water discharged was 39,663,500,000 gallons, equivalent to an average of 108,667,000 gallons per day for the entire year.

The Westborough State Hospital pumped 59,767,000 gallons of water during the year, equivalent to a consumption of 163,700 gallons per day, from the aqueduct at the terminal chamber.

The masonry aqueduct, open channel and appurtenances are in good condition with the exception of the Assabet Bridge. The granolithic walk on top of the bridge is in poor condition and should be relaid, and there is some leakage from the aqueduct at the westerly end of the bridge. The interior and exterior iron and wood work of the terminal chamber have been cleaned and painted, and the slate roof and copper gutters repaired. The iron railings and picket fences at the Assabet Bridge, at the upper and lower dams and at eight highways were painted with Smith's Durable Metal Coating, and the exterior of the barn and tool-house near the terminal chamber has been painted.

A Wheelock wire fence, 900 feet in length, was erected on the property line at land of James A. McHale in Southborough, and another 907 feet in length at the H. V. Perry land in Northborough, to replace the original board rail fence erected in 1897. New posts were set and the Wheelock wire fence erected in 1909 was restrung for a length of 865 feet on the property line at land of Charles F. Leland in Southborough. New posts were set and the wire fence erected in

1897 was restrung for 1,118 feet on the property line between pasture land under the control of the Westborough State Hospital and water works land in Big Crane Swamp in Westborough. An old stone wall on the property line at land of James B. Johnson in Little Crane Swamp in Northborough was rebuilt and topped with three strands of wire fencing for a distance of 273 feet.

Brush, grass and weeds have been mowed and disposed of for a distance of 10 miles along the aqueduct at a cost of about $96 per mile.

A Ford automobile, fitted with a light truck body, was purchased in March for the use of the foreman in charge of work along the lower 6 miles of the aqueduct and the 15 miles of swamp drainage ditches tributary to the open channel.

Sudbury Aqueduct. — During the year the Sudbury Aqueduct was in service for conveying water from Framingham Reservoir No. 3 to Chestnut Hill Reservoir with the exception of nine hours on June 26, when the flow was stopped for the purpose of filling Farm Pond with water from Framingham Reservoirs Nos. 1 and 2 through the supply aqueduct. The total quantity of water discharged through the aqueduct to Chestnut Hill Reservoir was 27,241,200,000 gallons, equivalent to an average of 74,633,000 gallons per day for the entire year, which is 19,080,000 gallons per day more than in 1917.

A hot water heating system was installed for the garage near the Framingham office, the heater being put in a concrete addition in the rear of the garage but without any opening into the garage.

The culverts along the aqueduct were kept free from snow and ice during the winter, and brush, grass and weeds were mowed along the aqueduct land where this work is not done by the adjoining owners.

Weston Aqueduct. — Water was supplied from the Sudbury Reservoir to the Weston Reservoir through the Weston Aqueduct on 314 days during the year. The total time that the aqueduct was in service was equivalent to 187 days, 17 hours and 11 minutes. The total quantity of water discharged was 18,436,700,000 gallons, equivalent to an average of 50,512,000 gallons per day for the entire year, which is 1,567,000 gallons per day less than for the previous year.

As the Weston Aqueduct is now used in connection with the Sudbury power station, which is not operated on Sundays or holi-

days, except under unusual circumstances, the total flow for each week was discharged between 7 A.M. and 11 P.M. until April 29, and since then between 6.45 A.M. and 10.45 P.M. on the other days.

The exterior and interior ironwork at the head-house and manhole covers along the aqueduct were painted. The iron braces supporting the baskets on the screens in the head-house had rusted out and new braces were put in and the lower part of the screens was otherwise repaired. It is noticed that the screens deteriorate more rapidly with the intermittent flow which is maintained in the aqueduct in connection with the operation of the power station than formerly when a continuous flow was maintained.

The exterior of the house at the White place in Nobscot was given two coats of paint and new steps were built at the rear porch. In the interior of the house the woodwork in the kitchen, dining room and two bedrooms was given one coat of paint.

Sprouts and brush were mowed in the 5-foot lanes along property lines for a distance of 0.64 of a mile near the White place.

The culverts along the aqueduct were kept free from snow and ice during the winter. Short lengths of fences were repaired by setting new posts at several places.

Cochituate Aqueduct. — The Cochituate Aqueduct was in use on three days in January and nine days in February, a total of twelve days during the year for conveying water to Chestnut Hill Reservoir. The total time that the aqueduct was in use is equivalent to 11 days and 2 hours. The total quantity of water discharged was 154,500,000 gallons.

The culverts along the line were kept free from snow and ice during the winter months. A Wheelock wire fence was built for a distance of 968 feet near North Main Street, Natick, along Snake Brook, to prevent cattle in the adjoining pasture from entering the brook.

The Newton & Watertown Gas Light Company laid a line of 12-inch pipe across the aqueduct on the southerly side of Commonwealth Avenue, between Furber Lane and Center Street in Newton. The pipe was laid with leaded joints for a distance of 96 feet where it crosses the aqueduct.

Sanitary Inspection of Watersheds.

The Sanitary Inspector and an assistant have made the usual investigations of conditions on the Wachusett, Sudbury and Cochituate watersheds for the purpose of protecting the water supply from pollution. A summary of the work is given in the accompanying tables.

Ice cutting operations were inspected at the various reservoirs and ponds during the winter and special watchmen were employed during the summer to prevent bathing and unauthorized boating or fishing in the reservoirs.

Wachusett Watershed.

The Mount Pleasant House in Jefferson, which had formerly been kept open during the entire year, was closed November 1. The sand filter-beds constructed by the department in 1905 to purify drainage from this hotel have given good results and were operated satisfactorily during the extreme cold weather in January, February and March by the proprietor.

There are now many farms on the watershed occupied by the owners only during the summer, the principal operation being the harvesting of the hay crops.

The mills at Jefferson, Dawson and Quinepoxet have been very busy on war orders during the past year and such attractive wages were paid, even for unskilled labor, that many small farms were temporarily abandoned which will probably be occupied again when the unusual demand for labor in the mills ceases.

Three coal pockets and a small office have been built at the Warren tannery site in Holden. The sanitary conditions at this place are now satisfactory.

There were 12 new buildings constructed on the watershed during the year and as 2 were eliminated there has been an increase of only 10 premises, making a total of 1,740 at the end of the year.

There was no case of typhoid fever reported on the watershed during the year.

Summary of Sanitary Inspections on the Wachusett Watershed in 1918.

DISTRICT.	Number of Premises inspected.[1]	Classification of Cases inspected.													Condition at End of Year.		Water Supply.		
		Cesspools dug before 1918.	Cesspools dug during 1918.	Direct Privy Drainage.	Indirect Privy Drainage.	Direct Sink Drainage.	Indirect Sink Drainage.		Barn Drainage.		Manufacturing Wastes.	Premises Vacant.	No Drainage.	Drainage carried to Filter-beds.			Premises having Public Supply.	Premises having Private Supply.	Premises on which no Water is used.
							Satisfactory.	Unsatisfactory.	Satisfactory.	Unsatisfactory.					Satisfactory.	Unsatisfactory.			
French Brook,	70	43	-	-	-	-	21	-	17	-	-	5	2	-	70	-	7	56	7
Muddy Brook,	42	19	-	-	-	-	19	-	17	-	-	2	1	-	42	-	-	39	3
Gates Brook,	216	155	2	-	-	-	45	2	53	1	-	9	3	-	214	2	4	200	12
Malden Brook,	34	15	-	-	-	-	17	-	20	-	-	1	1	-	34	-	-	32	2
Chaffin Brook,	215	132	3	-	-	-	63	6	86	-	1	5	5	-	208	7	89	116	10
Asnebumskit Brook,	219	160	3	-	2	9	26	2	45	2	2	9	9	1	204	15	182	18	19
Muschopauge,	93	40	3	-	-	-	37	-	41	-	1	5	5	1	92	1	7	72	14
South Wachusett Brook,	87	39	1	-	-	-	36	-	41	1	-	8	3	-	86	1	-	76	11
Trout Brook,	34	5	-	-	-	-	23	-	20	-	-	3	2	-	34	-	-	29	5
East Wachusett Brook,	217	87	2	-	-	-	86	3	93	-	-	26	15	1	214	3	-	176	41
Stillwater River,	144	70	-	-	-	-	47	1	63	3	-	14	11	1	141	3	-	119	25
Waushacum,	334[2]	81	-	-	-	-	71	2	58	1	-	4	15	94	331	3	-	315	19
French Hill,	35	26	-	-	-	-	6	-	14	-	-	2	1	-	35	-	-	32	3
Totals,	1,740	872	14	-	2	9	497[3]	16	568	8	4	93	73	98	1,705	35	289	1,280	171

[1] On some premises there are two or more cases. [2] Including 160 summer dwellings at the Waushacum Ponds. [3] Summer dwellings not classified.

Summary of Sanitary Inspections on the Sudbury and Cochituate Watersheds in 1918.

DISTRICT.	Number of Premises inspected.[1]	Classification of Cases inspected.														Condition at End of Year.	
		Sewer Connections.	Cesspools dug before 1918.	Cesspools dug during 1918.	Direct Privy Drainage.	Indirect Privy Drainage.	Direct Sink Drainage.	Indirect Sink Drainage.		Barn Drainage.		Manufacturing Wastes.	Premises Vacant.	No Drainage.	Drainage carried to Filter-beds.	Satisfactory.	Unsatisfactory.
								Satisfactory.	Unsatisfactory.	Satisfactory.	Unsatisfactory.						
Sudbury Watershed.																	
Farm Pond,	328	316	6	-	-	-	-	-	-	8	-	-	-	4	-	328	-
Framingham Reservoir No. 3,	98	-	66	3	-	-	-	23	-	44	1	-	6	-	-	97	1
Stony Brook,	302	-	255	4	-	-	-	22	2	33	2	-	10	6	2	298	4
Angle Brook,	2,032	1,656	261	5	-	-	-	83	1	171	-	-	9	16	1,831	2,031	1
Framingham Reservoirs Nos. 1 and 2 and Cold Spring Brook,	337	-	257	3	-	-	-	60	1	98	-	-	14	2	-	336	1
Eastern Sudbury,	232	-	213	1	-	-	-	8	-	26	-	-	3	6	-	232	-
Indian Brook,	403	-	234	-	-	-	-	102	6	63	3	-	54	7	-	394	9
Western Sudbury,	183	-	106	-	-	-	-	45	4	50	1	1	18	9	-	178	5
Whitehall Reservoir,	177	-	58	-	-	-	-	81	-	35	1	-	36	2	-	176	1
Cedar Swamp,	797	550	173	2	-	2	-	41	3	97	-	-	30[3]	13	-	794	3
Totals,	4,889	2,522	1,629	18	-	2	-	465	17	625	8	1	180	65	1,833	4,864	25
Cochituate Watershed.																	
Snake Brook,	249	-	185	6	-	1	-	15	1	27	1	-	42	-	-	248	1
Pegan Brook,	1,090	783	249	1	-	-	-	31	-	66	-	1	15[4]	13	1,022	1,090	-
Course Brook,	139	2	108	-	-	-	-	16	-	33	-	-	10	1	-	139	-
Beaver Dam Brook,	1,738	1,352	296	9	-	-	-	51	2	120	1	-	11	16	1	1,735	3
Totals,	3,216[2]	2,137	838	16	-	1	-	113	3	246	2	1	78	30	1,023	3,212	4

[1] On some premises there are two or more cases.
[2] Including 210 summer dwellings.
[3] Fifteen of these premises connected with the public sewer.
[4] Four of these premises connected with the public sewer.

Sudbury Watershed.

On the Sudbury watershed there were 4,877 premises at the beginning of the year and 4,889 at the end of the year, an increase of 12 premises during the year, resulting from the construction of 13 buildings and the elimination of 1 building. Five of the new premises are connected with public sewers which carry the drainage off the watershed.

Building activities were limited to the completion of houses begun in previous years and to the construction of new factories or additions to existing factories engaged on war contracts.

The drainage from the Deerfoot farm factory and the Fay and St. Mark's schools in Southborough has been satisfactorily cared for by the owners of these properties.

Sixteen cases of typhoid fever were reported from Marlborough during the year, 12 of which were caused by polluted milk supply. In 12 cases the premises are connected with the public sewers which carry the drainage off the watershed, and in the other four cases the premises are provided with cesspools.

Cochituate Watershed.

On the Cochituate watershed there were 3,198 premises at the beginning of the year and 3,216 premises at the end of the year, an increase of 18 premises, which results from the construction of 19 buildings and the elimination of 1 building. Seven of the new premises are connected with the public sewers which carry the drainage off the watershed.

As in the case of the Sudbury watershed, building activities were limited to the completion of houses begun in previous years and to the construction of new factories or additions to existing factories engaged in war contracts.

Many summer cottages on this watershed were not occupied during the year and the building boom near Lake Cochituate was limited to the construction of 5 cottages.

Concrete settling basins are being constructed by the Natick Box Company to prevent the discharge of large quantities of paper pulp which now flows from its premises into an adjoining brook causing a nuisance along its course and at the intercepting reservoir near the Pegan pumping station.

At the beginning of the year the manufacturing industries in Framingham were greatly hampered by the coal shortage, but the twenty largest companies employed about 8,000 hands. During the summer this number was increased to about 10,000, but since the signing of the armistice it has fallen rapidly and not over 4,000 were employed at the end of the year.

During the year 3 cases of typhoid fever were reported from Framingham in houses connected with the public sewers and 1 case was reported from Natick in a house which was connected with a cesspool.

Protection of the Water Supply.

Filtration and Chlorination.

On the Wachusett watershed the surface water from 525 acres in the village of Sterling has been filtered at the Sterling filter-beds. The sewage from the Worcester County Training School has been purified at the filter-beds on Beaman Street in West Boylston. This institution now accommodates 74 boys and teachers. The sewage from five small cottages at Sterling Junction was filtered at the Gates Terrace filter-beds from April 15 to October 30, while the cottages were occupied. The cost of maintaining all of these filter-beds was $860.93, including an expenditure of $135.43 for replacing with reinforced concrete the wooden troughs at the Worcester County Training School filters, which had been in use since the filters were constructed in 1903.

On the Sudbury watershed the surface water from an area of two square miles in Marlborough has been filtered at the Marlborough Brook filter-beds before entering the Sudbury Reservoir, with the exception of 70,400,000 gallons on February 15, 16, 19, 21 and 26 and March 1 and 2, which the filters could not take care of and as it overflowed at the wasteways it was treated with calcium hypochlorite with the exception of about 2,400,000 gallons which was not treated because of delay in receiving the calcium hypochlorite. Diluted sewage from the Marlborough main sewer was received at the combined storage reservoir and filter-bed on Farm Road on February 15, 16, 20 and 26 and March 1, April 21 and 22 and September 27. Ground water from the sewer underdrain was filtered at the Farm Road bed during every month except January. The filter-beds received the usual attention; the weeds and grass on the artificial beds were cut and

removed by the one-horse weeder and cultivator and the natural beds were cleaned by removing the surface deposit in the early summer and late in the fall the hardened surface of the beds was harrowed and the large stones which were loosened were removed. Cracks in quite a number of dams at the inlets of distributing channels and in the concrete aprons of the beds were cut out and pointed. Paving at the outlet of bed No. 2 was relaid, a new driveway was built from the street to bed No. 19 and the office and sheds were painted.

The drainage from the Southborough swimming pool was filtered at the bed near Boston Road and the pool and filter-bed were cleaned once during the season. On account of a crack in the vault in the outhouse connected with the pool the outhouse was closed on June 27 and the bathhouse on July 9. On account of difficulty in obtaining labor to make the necessary repairs and of securing watchmen to look after the swimming pool the Selectmen of Southborough stopped the use of the pool July 15.

The surface water from Cherry Street Brook at Fayville was treated with calcium hypochlorite whenever there was any surface wash from the premises which drain into this brook.

The cost of the filtration and chlorination work on the Sudbury watershed was $2,608.74.

On the Cochituate watershed the surface water from an area of about one square mile of the thickly settled portion of the town of Natick was pumped at the Pegan station and filtered before it entered the lake, with the exception of the overflow from the Pegan receiving reservoir on January 12, February 15, 20 and 26 and March 1, amounting to 4,500,000 gallons, and from the intercepting reservoir except on January 12, February 13 to 16, inclusive, February 19, 20, 26 and 27, March 1, 2, 6, 7, 10 and 13 to 16, inclusive, and April 22, amounting to 28,500,000 gallons, and the overflow at Kansas Street on February 15 and 16, amounting to 3,000,000 gallons. All of this water, which overflowed directly into the lake was treated with calcium hypochlorite except the 3,000,000 gallons at Kansas Street.

The pumping station was operated on 215 days during the year and 271,547,000 gallons of surface water, equivalent to an average of 743,964 gallons per day for the entire year, were pumped to the filters. The cost of operating and maintaining the pumping station and filters

was $5,664.84 which is equivalent to a cost of $20.86 per million gallons.

The filter-beds were cleaned and weeded several times in order to keep them in proper condition. The deposits in the brook and ditches, the receiving reservoir and intercepting reservoir and ditch were removed and teamed away. A deposit of paper pulp from the factory of the Natick Box Company, about 18 inches in depth and amounting to 980 cubic yards, was removed from the bottom of the intercepting reservoir by pumping it onto bed No. 6. The cost of this work is paid for by the Natick Box Company which is now nstalling settling tanks at the factory with a view to keeping this deposit out of the brook.

The force employed at this station during the summer has been larger than usual in order to clean up the grounds around the station and the approach to the station from Washington Avenue so that they will be in satisfactory condition. This work has increased the maintenance expenses at this station somewhat above the expenditures during previous years.

Improvement of Swamps and Brooks.

The ditches maintained in the swamps on the watersheds for improving the quality of the water were cleaned and the weeds and brush were mowed for a width of 10 to 20 feet on both sides where necessary.

This work was done in the Wachusett Department along 23.5 miles of the 27.73 miles of ditches, some of the ditches in remote and unimportant locations being given less attention than usual this year. The cost of the work was $823.14.

The cost of the usual cleaning and mowing along the 8.94 miles of ditches which are cared for by the Sudbury Department was $444. The sod and grass were removed from the paving and repairs were made at various places, including 317 linear feet of new board bottom, 336 linear feet of new corner pieces and 150 square yards of paving taken up and relaid, the total cost of the repairs being $744.28.

The work of improving Gates Brook in the Wachusett watershed at the district known as "The Settlement," which was suspended on September 20, 1917, was not resumed on account of the scarcity of labor and high cost of materials.

For the protection of the water supply 28.75 acres of land located on Main Street in Boylston and 9.67 acres located along Waushacum Brook in Sterling were acquired on the Wachusett watershed during the year, and for the same purpose the fee was acquired in 2.44 acres of land located in Little Crane Swamp in Northborough on the Sudbury watershed, where drainage ditches tributary to the open channel portion of the Wachusett Aqueduct had previously been constructed under an easement acquired in July, 1899.

Clinton Sewage Disposal Works.

Chapter 557 of the Acts of the year 1898 provides that works for the disposal of the sewage of the town of Clinton shall be maintained and operated by the Metropolitan Water Works until the sewage of said town shall have outgrown the normal capacity of the South Branch of the Nashua River to properly dispose thereof.

As a result of informing the town officials that in our opinion the time is near at hand, if it has not already been reached, when this provision of the statute should become operative, the town appointed a committee to investigate and report upon the leaky condition of the sewers and any other causes for the excessive quantity of sewage which is now received at the pumping station. This committee employed a civil engineer to make an investigation and report to the annual town meeting which will be held in March, 1919.

In connection with the operation of the works the pumping station was operated daily and the quantity of sewage pumped to the filter-beds was equivalent to 1,065,000 gallons per day throughout the year, which is 15,000 gallons per day more than in 1917 and about equivalent to the average of the past seven years.

The Blake compound duplex pump and the boiler have been kept in reserve for service in case of emergency. All of the sewage was pumped with the electrically driven 12-inch DeLaval centrifugal pump installed in 1912. The pumping statistics are as follows: —

Total pumpage (gallons),	388,679,000
Average pumpage (gallons per day),	1,065,000
Electric energy used (kilowatt hours),	126,220
Pumpage per kilowatt hour (gallons),	3,079
Average lift (feet),	49.7
Efficiency of pumping unit and transmission line (per cent.),	53.4
Coal used for burning sludge and heating (pounds),	58,171

Cost of pumping: —

Labor,	$1,337 04
Electric energy at $5.30 per thousand kilowatt hours,	668 97
Coal for burning sludge and heating,	170 61
Repairs and supplies,	333 12
Total for station,	$2,509 74
Cost per million gallons,	$6 46
Cost per million foot gallons,	0 1299

Filters.

The filter-beds and settling basins were operated jointly daily throughout the year by first passing the sewage through one of five settling basins the effluent from which was applied to the 25 one-acre sand filter-beds in regular doses of 59,000 gallons of sewage in 30 minutes, at intervals of about $1\frac{2}{5}$ days, equivalent to about 41,500 gallons per acre per day. The cost of maintaining the filters during 1918 was as follows: —

Labor,	$4,417 29
Supplies and expenses,	996 32
Total,	$5,413 61
Cost per million gallons,	$13 93

The character of the effluent, as shown in the following table, has continued to be much less satisfactory than in years previous to 1916, due to the condition of the filtering material near the surface of the beds.

[Parts per 100,000.]

	1915.	1916.	1917.	1918.
Albuminoid ammonia, sewage,	1.4350	1.0255	.8652	.8792
Albuminoid ammonia, effluent,	.09347	.0983	.1383	.1439
Reduction, per cent.,	93.5	90	84	83.6
Free ammonia, sewage,	3.7867	2.7850	3.4707	3.2300
Free ammonia, effluent,	.5924	1.0316	1.7658	1.5094
Reduction, per cent.,	84	63	49	53
Nitrogen as nitrates, effluent,	.7152	.3693	.20165	.2866
Iron, effluent,	.30815	1.052	2.036	1.903
Average quantity of sewage filtered, gallons per day,	941,000	1,225,000	1,050,000	1,037,000

During September, October and November experiments were made in washing the filtering material on one of the gravel beds for a depth of 6 to 10 inches. This surface material had become thoroughly filled with organic matter and the efficiency of the filter had been greatly reduced. As there was no good filtering material in the vicinity of the beds the cost of removing the dirty gravel and replacing it with new material would have involved much expense and it was therefore decided as a matter of economy to wash the dirty gravel and replace it on the beds. This is a common practice in connection with the operation of water filters but a novelty in connection with the operation of sewage filters.

Bed No. 5 was chosen for the experiment as it was conveniently located for the purpose so that the effluent from the filters could be used for wash water and this bed represented about an average condition of all the gravel beds.

The gravel washing plant consisted of a No. 1 Stocker gravel washer, driven by a belt-connected 2½-horse power Alamo gasoline engine mounted on a wooden frame and moved about on wooden rollers; a small portable pumping unit consisting of a Swaby centrifugal pump with a capacity of 75 gallons per minute operated by a 1¾-horse power Brownwall gasoline engine. About 450 feet of 2½-inch fire hose was used between the pump and the washer for conveying the washing water, and wooden troughs were used for disposing of the dirty water from the washer. The cost of this outfit fully equipped and set up ready for operation was $629.63 for the apparatus and $124.89 for labor, making the total cost $754.52.

The Stocker gravel washer consists of a steel cylinder 8 feet long and 30 inches in diameter, to the inside of which are riveted steel angles running lengthwise of the cylinder about 3 inches apart. Hung from an independent frame inside the cylinder are a number of sheet steel chutes the inclination of which may be varied to meet the requirements. The dirty material is fed into the revolving cylinder at one end and conveyed through it by alternately dropping down the chutes and being carried up again to the next one by the angle strips. The clean water enters at the other end of the cylinder and passes slowly through the washer in the opposite direction to the material. In this way the material gets several washings and scourings, each time with cleaner water, until finally the dirty water and material washed out of the gravel is discharged at one end and the clean material at the other end.

The bed is about 200 feet square and has an area of 1.02 acres. For convenience the dirty material was scraped from sections of the bed about 50 feet wide and conveyed to the washer with a one horse drag scoop and then shoveled into the hopper, the washer being moved along the section as the work progressed. The washed gravel was shoveled into piles and later graded into place with the drag scoop after the surface of the bed which had been worked over was loosened with a harrow to break up any stratification that might occur between the washed material and the gravel which had not been disturbed by the operation. The residue from the process which did not pass off with the wash water was hauled away in carts to the dump.

About 1,100 cubic yards of material was washed in this manner with a loss of about 20 per cent. in volume. This represented approximately 75 per cent. of the organic matter and sludge which had caused the sealing of the filters, and a small per cent. of the finer sand grains in the gravel. After the washed material was replaced on the bed the surface was about 0.13 of a foot lower than before operations began.

The force employed included 7 men and 1 horse all the time and 2 men and 1 horse additional when regrading was being done. The cost of this experimental work was $2,646.40, of which $754.52 was expended on the plant. Assuming that the plant will be used on at least 20 beds the portion of its cost chargeable to bed No. 5 would be only $37.73 and the total cost chargeable to this bed would be $1,929.61, and the cost per cubic yard of material washed is $1.75. Experience shows that by equipping the washer with an elevator for handling the washed material, a sludge pump and pipe line for removing the dirty water and sludge, and by undertaking the work in a systematic manner the cost should be materially reduced in the future.

Observations made during the month that this bed has been in service since the work was completed indicate that considerable benefit has resulted. The sewage now enters the bed freely when applied in doses of 62,000 gallons in 30 minutes at intervals of about 1.6 days, which is equivalent to a rate of filtration of about 38,000 gallons per acre per day, and dissolved oxygen is again present in the effluent.

FORESTRY.

Wachusett Department.

The 76.3 acre parcel back of the Westerly Portion of the North Dike at the Wachusett Reservoir, which was cleared and planted in 1917 with white pine seedlings spaced 12 feet apart in rows 12 feet apart, has been further developed by interplanting with red pine seedlings 3 years old and white pine seedlings 4 years old, making the trees in the finished planting 6 feet apart in rows spaced 6 feet apart. The remainder of the white pine seedlings raised in the North Dike nursery were used in this work and the nursery was discontinued and included in the planted area. The total number of trees used in this work in 1917 and 1918 is as follows: —

White pine seedlings, 4 years old, planted in 1917, ...	23,000
Red pine seedlings, 3 years old, planted in 1918, ...	43,000
White pine seedlings, 4 years old, planted in 1918,.	33,350
	99,350

About 7,000 of these were used to fill in failures.

Parcels of water works land located along the margins of the Wachusett Reservoir in Sterling, Boylston and West Boylston, aggregating 90 acres, were planted with white pine seedlings 3 and 4 years old and white spruce seedlings 6 years old from the Oakdale nursery. In this work 91,700 white pine, 43,000 red pine and 1,300 white spruce seedlings were used. The cost of preparing the trees in the nurseries and field planting was $14.41 per thousand. An access road 900 feet in length, 15 feet wide with margins 15 feet on each side, was constructed through one of the lots.

Sixty acres of water works land bordering on the Wachusett Reservoir and tributary streams, which had been recently burned over or was grown to chestnut trees seriously damaged by the chestnut bark disease, or was badly infested with the gypsy moth, were cleared for planting with white pines. This work cost $2,820 or about $47 per acre, and cord wood and fence posts having a value of $1,190 were obtained.

A quantity of white pine seed collected and stored during 1917 was planted in seed beds in the Oakdale nursery last spring and 134,000 white and red pine seedlings 1 year old furnished by the

State Forester's department from the nursery at Amherst were set out in transplant beds, but on account of their condition when received, and the unfavorable weather which immediately followed the transplanting, about 60 per cent. of them died.

Many of the Scotch pine seedlings in the Oakdale nursery were attacked with the blister rust and upon the advice of the Nursery Inspection Department of the Commonwealth were destroyed. It is probable that the entire lot now on hand will also have to be destroyed as the sweet fern, which is the alternate host necessary for the spread of this disease, is very prevalent on the water works land.

The necessary care has been given to the trees in the Oakdale nursery, which at the end of the year contained the following: —

White pine seedlings, 1 year old, in seed beds,	191,000
White pine seedlings, 2 years old, in transplant beds,	51,000
White pine seedlings, 3 years old, in transplant beds,	6,900
White pine seedlings, 4 years old, in transplant beds,	44,000
White pine seedlings, 5 years old, in transplant beds,	13,000
Scotch pine seedlings, 4 years old, in transplant beds,	38,000
Red pine seedlings, 2 years old, in transplant beds,	3,400
Red pine seedlings, 6 years old, in transplant beds,	100
Norway pine seedlings, 4 years old, in transplant beds,	200
White spruce seedlings, 7 years old, in transplant beds,	10,000
Tamarack seedlings, 3 years old, in transplant beds,	5,800
Sequoia seedlings, 7 years old, in transplant beds,	100
Maple seedlings, 2 years old, transplanted from field,	750
	364,250

The sprouts and undergrowth which were interfering with the pines on about 177 acres of land planted during the past few years were cut and disposed of at a cost of about $14 per acre. Where these plantings were along main highways the brush was removed and burned for a width of 100 feet from the roadside; at other points it was left to die and rot on the ground.

Improvement thinning was made on 14 acres of timber land on the margin of the Wachusett Reservoir in Clinton and West Boylston at a cost of $577.37, and cordwood which was sold for $385 was obtained from this work.

The improvement thinning begun in 1916 of a portion of Big Crane Swamp in Westborough, which was thickly grown with cedars,

was continued in the early spring and 1,310 first class fence posts obtained from this work were used in connection with fence repairs and 400 first class fence posts were stored for future use. At the close of the year this work has been resumed and fence posts and saw logs for the manufacture of shingles are being obtained.

The trees and shrubbery at the Wachusett Dam and the trees on water works land adjacent to the main highways about the Wachusett Reservoir and Waushacum Ponds, the Sterling and Clinton sewerage filter-beds, which were infested with gypsy moths were sprayed with 4,500 pounds of arsenate of lead during May and June at a cost of $1,104.88.

During the past few years considerable time and money have been spent in an attempt to check the spread of the gypsy moth by scouting for and painting with creosote the egg clusters, but it does not appear practical to thoroughly prosecute this work in the large wooded areas around the Wachusett Reservoir, and, as the abutting woodland is not similarly treated by the private owners and the United States Government has planted gypsy moth parasites in this territory, our attempt to check the spread of the gypsy moth during the past year has been confined almost entirely to spraying. There were, however, 4,500 gypsy moth egg clusters found and painted with creosote on the trees and shrubbery at the Wachusett Dam at a cost of $89.88.

During June and July many of the white pine plantings on the marginal lands around the reservoir were inspected for the pine-tree weevil on two occasions, at a cost of $152.18. During the first inspection 7,300 leaders were cut and burned and 450 during the second inspection. The work was confined to the areas having trees of medium height and under, as larger trees are less affected, the work more difficult and the expense is hardly warranted.

The total cost of protecting the trees and plantings from insects and disease during the year was $1,346.94.

The usual fire patrol service was maintained during the spring and fall. Three forest fires, involving considerable damage to the white pine trees, occurred during March and April when the conditions were particularly favorable. On March 24 sparks from a locomotive on the Boston & Maine Railroad started a fire among the young pines on the lot in Oakdale between Pleasant Street and the Still-water River. About 11 acres were burned over and approximately

13,000 trees destroyed. The Railroad Company reimbursed the Commonwealth for the loss which amounted to $265.50. On April 7 trespassers near the North Dike started what would undoubtedly have been a very serious fire but for the prompt action of our patrolman, who, with the assistance of some neighbors, put out the fire with a loss of about 28 pine trees from 6 to 15 feet high and 80 pine trees about 2 feet high. In this case the offenders were summoned into court and heavy fines imposed. On April 15 about 11 acres of land on the margins of the reservoir in Sterling, planted to white pines from 2 to 4 feet high, were burned over destroying about 13,000 trees. This fire started from the operations of the department employees who were burning brush in this vicinity.

The brush, grass and weeds on 1¾ miles of marginal fire guard, which is 40 feet wide, and on 1¼ miles of forest roads from 15 to 45 feet wide, were mowed and burned at a cost of $153.28.

At the close of the year the water works lands in the Wachusett watershed may be classified as follows: —

Forest lands acquired and not since improved (acres),	1,357
Forest lands acquired and since improved (acres),	330
Land which has been planted with trees and not cleared (acres),	238
Land which has been planted with trees and since cleared (acres),	1,283
Land to be planted with trees (acres),	588
Open land which will probably not be planted (acres),	820
Marginal strip along shore of the reservoir (acres),	212
Total,	4,828

The total expenditures for forestry during the year in the Wachusett Department were $14,860.

Sudbury Department.

In May 150,000 white pine seedlings 2 years old and 50,000 4 years old were received from the State nursery at Amherst, of which 125,000 2 years old and 10,000 4 years old were set out in the nursery at the Sudbury Reservoir.

White pine seedlings from this nursery were planted as follows: 40,800 seedlings 3 years old at the Sudbury Reservoir east of Acre Bridge, on land cleared back of the Bigelow place on Farm Road and at several other places; 1,900 seedlings 4 years old at Whitehall Reservoir; and 13,100 seedlings 4 years old at Framingham Reservoir No. 3.

Along the Weston Aqueduct white pine seedlings 4 years old were set out as follows: 1,400 east and west of Edgell Street; 1,400 at the White place; 1,750 east of gaging chamber No. 2; 800 west of Elm Street; 1,000 west of Pine Ridge Street, and 600 at the west portal of Tunnel No. 4.

Along the Sudbury Aqueduct 8,500 seedlings were field planted on the slopes of the cut easterly of the first crossing of Wellesley Avenue and 3,000 were field planted on the stretch of land on the southerly side of the Cochituate Aqueduct east of Morse's Pond.

At Lake Cochituate a small nursery was established near the woods opposite the foreman's house on West Pond Street, and 25,000 seedlings 2 years old and 6,550 4 years old were set out for future use.

There are now on hand at the nursery at Sudbury Reservoir 125,000 white pine seedlings 2 years old and 10,000 4 years old.

Part of the trees at the Sudbury Reservoir, Framingham Reservoirs Nos. 1, 2 and 3, Lake Cochituate and at the White place and near siphon chamber No. 2 on the Weston Aqueduct were sprayed with arsenate of lead in May and June. The power sprayer was in use 24 days with an average force of 9 men on this work and 8,000 pounds of arsenate of lead were used. The total cost of the work was $2,044.53.

Brown-tail moth caterpillars were destroyed within 50 feet of the highways at the Sudbury and Framingham reservoirs and incidentally at other places in connection with spraying work.

Gypsy moth egg masses were painted with creosote as follows: 43,400 at the Sudbury Reservoir, 8,300 at the Framingham reservoirs, 35,600 along the Cochituate Aqueduct, 10,600 along the Sudbury Aqueduct and 55,000 along the Weston Aqueduct, at a cost of $539.60.

The pine trees at Sudbury, Ashland and Hopkinton reservoirs and along the Weston Aqueduct were inspected for the pine-tree weevil and 14,600 leaders were cut off and destroyed at a cost of $338.21.

At the Sudbury Reservoir 11,300 feet of new fire guard 40 feet in width and 6,400 linear feet of forest lanes 40 feet in width were cut and the brush was mowed on 12,740 feet of old fire guard and 3,127 linear feet of old forest lanes. The cutting of fire guard and forest lanes is now practically finished at this reservoir. The total length is 4.55 miles of fire guard and 1.81 miles of forest lanes.

The wood on about 15 acres of land east of Acre Bridge, Marlborough, and in the rear of the Bigelow place on Farm Road was sold to various parties who also cut and burned the brush and limbs. About 8 acres of land were cleared by the department force on Pine Hill; the wood was sold and the brush burned. An improvement thinning was also made among the deciduous trees on the hill and 1,300 chestnut posts were obtained where chestnut trees affected with the bark disease were cut down. Grass and brush between the field planted pines and the highways were cut and burned and the lower limbs of many pine trees which were dragging on or very near the ground were cut off to protect them from fire. On Robinson and Nichols hills on the southerly side of Sudbury Reservoir the brush was cut where it was interfering with the growth of the field planted pines.

At Framingham Reservoir No. 3 scrub oaks infested with the gypsy moth were cut on the west shore of the reservoir for a distance of about 1,800 feet northerly from the New York, New Haven & Hartford Railroad, and all the wood was cut on the two islands in the reservoir. All of the wood that was of any value was used for fuel at the gate-houses and the brush and limbs were burned on the ground.

All of the trees for a distance of about 300 feet along the Cochituate Aqueduct west of Oak Street in Natick, except the pines and some large maple trees, were cut and the wood was hauled to the gate-house at the lake and used for fuel.

During the year there were two forest fires at Sudbury Reservoir, burning over an area of about 0.4 of an acre and destroying 200 trees; three at Framingham Reservoir No. 3, burning over an area of about 4 acres and destroying 3,500 trees; two at Framingham Reservoir No. 2, in which no trees were burned but 120 feet of old fence destroyed; one at Lake Cochituate burning over a small area on the west shore but causing no damage; one on the Cochituate Aqueduct on the westerly side of Walnut Street in Newton, in which 200 transplanted pines 5 inches to 12 inches in height and 20 pines 2 feet in height were destroyed; one on the south side of the Cochituate Aqueduct burned over an area of about 1 acre and destroyed 1,000 transplanted pines 8 inches high, and one on the Weston Aqueduct at the entrance to tunnel No. 4 in which 400 white pines 5 years old averaging 15 feet in height were burned.

Several of the fires were of unknown origin, five were caused by sparks from locomotives on the adjoining railroads and two by the carelessness of adjoining owners. There has been received in settlement from the railroad companies and adjoining owners for the damage done $738.81.

The total amount expended for forestry in the Sudbury Department during the year was $8,287.89.

Distribution Reservoirs.

Gypsy and brown-tail moths and elm-leaf beetles were destroyed on water works lands around the distributing reservoirs as in former years by spraying the foliage with arsenate of lead during the crawling season, by painting the gypsy moth egg clusters with creosote and burning the brown-tail moth webs during the winter.

The two-horse Fitzhenry-Guptill power sprayer was used for the spraying and 4,410 pounds of arsenate of lead in paste form were used.

Oyster scale, found on shrubs at Chestnut Hill Reservoir, was destroyed by using Scalecide and Arlington oil. The leaders on pine trees at the Weston Reservoir, which were infested with the pine-tree weevil, were cut off and burned.

Four fires occurred in the woods at Spot Pond during the year which burned over a total area of about 10 acres and destroyed 225 pines and 60 oak trees.

The total expenditures for forestry at the distribution reservoirs were $2,449.36.

HYDRO-ELECTRIC SERVICE.

The total quantity of electric energy delivered during the year from the two hydro-electric stations which are operated in connection with the Metropolitan Water Works was 14,109,355 kilowatt hours.

The total value of this energy at the contract prices is $80,270.64. The total expenses chargeable to both stations are $40,236.04, leaving a profit for the operation of the stations of $40,034.60, equivalent to $2.837 per thousand kilowatt hours.

Wachusett Power Station.

The Wachusett power station was operated on 298 days during the year. The energy not used in connection with the operation of the Metropolitan Water Works was sold to the New England Power

Company under an agreement made September 30, 1916, which provides that until the completion of the Wachusett–Sudbury transmission line the company will take as much energy from the Wachusett power station as it can reasonably and properly use without wasting water at its own plants. Under this arrangement 100 per cent. of the water drawn from the reservoir into the Wachusett Aqueduct was used to develop electric energy. The station has now been in operation 7½ years and this is the first year that all of the water drawn from the reservoir for water supply purposes has been used to generate electric energy.

An examination and test of the station equipment to determine what changes, if any, were necessary to ensure the safety of the operators and the equipment and to conform to the best modern practice, was made by experts from the laboratory of the Edison Electric Illuminating Company of Boston in January. Alterations of a minor character only were found to be necessary. A number of these changes have been made and the others will be completed as soon as the necessary materials are received. The principal change thus far made has been to substitute rigidly fixed bevel gears and connecting shafts in place of the sprocket wheels and chains which were formerly used for the operation of the machine rheostats, so as to remove the possibility of a broken chain falling across the bus bars. Asbestos wood barriers have been prepared to place at high voltage fuses and switches where damage might result from arcing.

Plans were made and the apparatus installed for utilizing so far as possible for the generation of energy the water which has to be wasted from the Wachusett Reservoir at times of extreme high water. This waste water could not formerly be used to generate electricity. The new apparatus consists of two large wooden electrically-operated sluice-gates installed at the entrance to the aqueduct, so arranged that all or any part of the water passing through the water wheels can be turned either into the aqueduct for water supply purposes or wasted through the pool into the Nashua River. In connection with this arrangement it has been necessary to increase the capacity of some of the transformers and meters used in measuring the electric energy and to rearrange the sanitary and other fixtures in the locker room.

The wooden head-gates are each 15 feet 6 inches long x 6 feet 5 inches wide, made up of 18 pieces of long leaf yellow pine plank each 9¾ inches wide and varying in thickness from 5¾ inches at the

bottom to 3¾ inches at the top. These planks are held together by means of two through rods 1 inch in diameter and two angle irons 6 inches x 3½ inches x ½ inch bolted to the ends. The joints in the planking and between the iron and wood work were made water tight by the use of splines, cotton wicking and asphaltum varnish. To the bottom of each gate there is attached a steel forged connection to which the lower end of a steel screw stem 2¾ inches in diameter is fastened. This stem operates in a gate stand set on the floor of the room above the entrance to the aqueduct and is driven by a 4½-horse power electric motor through a train of gears arranged to operate the gate at a speed of about 1 foot per minute. The gates travel vertically 13½ feet in iron grooves placed in the concrete walls at the entrance to the aqueduct, and the water when passing into the aqueduct flows beneath the gate which may be set at any desired elevation.

When operating the station and wasting water through the pool the elevation of the tail water in the well beneath the generating room will be nearly up to the underside of the floor and it became necessary to equip the Lombard governors with an automatic device for controlling the wicket gate openings on the water wheels within fixed limits. The operator in charge of the station originated and perfected an ingenious electrical device by which the gate is blocked at any desired opening under normal operation and is immediately brought under the free control of the hydraulic governor by the tripping of the circuit breaker in case of an interruption in service. Unit No. 2 has been operated with this device since last July, during which time it has been perfected, and the other units are now being equipped with the device.

To localize trouble and prevent the interruption of service on the New England Power Company's lines the Company, on September 14, installed reverse power relays at the station to operate in connection with two oil switches controlling the two cables through which energy is supplied to the Company, in addition to the relays which were provided by this department for the protection of our apparatus when it was installed. It is necessary to keep both underground cables in service all the time with this arrangement, but if both cables should break down simultaneously at any time the Company has agreed to install a temporary overhead line and make good any loss of revenue resulting from such failure of the cables.

The lightning arresters have been equipped with charging resistances and meters for determining the condition of the electrolyte so that they can be kept in proper condition at all times.

During an electrical storm on June 14 two series transformers on the station service lines were burned out and the station was idle for about six hours while temporary repairs were being made. New transformers, costing $146.31, have been installed. This was the only interruption of any importance which occurred during the year.

The Wachusett power station statistics for the year 1918 are as follows: —

Total energy developed (kilowatt hours),	8,343,450
Engery used at power station (kilowatt hours),	14,159
Available energy (kilowatt hours),	8,329,291
Water used (gallons),	39,663,500,000
Average head (feet),	91.4
Energy developed per million foot gallons (kilowatt hours),	2.30
Efficiency of station (per cent.),	73.24

Credits: —			
Energy sold New England Power Company, 8,203,071 kilowatt hours at $0.0053,		$43,476 28	
Energy furnished Clinton sewerage pumping station, 126,220 kilowatt hours at $0.0053,		668 97	
			$44,145 25
Charges: —			
Superintendence,		$1,037 91	
Labor, operating station,		6,325 38	
Repairs and supplies,		2,082 14	
Alterations and additions: —			
Labor,	$478 47		
Apparatus and supplies,	1,493 06		
		1,971 53	
		$11,416 96	
Taxes,		2,775 00	
Administration, general supervision, interest and sinking fund,		6,330 53	
			20,522 49
Profit,			$23,622 76
Cost of available energy per thousand kilowatt hours,			$2.464

Sudbury Power Station.

The Sudbury power station is usually operated 16 hours every day except Sundays and holidays, but was shut down this year on August 26 in connection with the work of painting the turbines and gate shafts, and on account of the large consumption of water during extreme cold weather was operated on Sunday January 6, on every Sunday from February 3 to March 31, inclusive, and on the holiday February 22 to furnish the amount of water required for supplying the District. The station was also operated on holidays April 19 and November 12 as it was desirable to draw water from the Sudbury Reservoir on those days for water supply.

The regular operating hours were from 7 A.M. to 11 P.M. until April 29 and since then the station has been started up at 6.45 A.M. and shut down at 10.45 P.M. so that the operators' working time on the second shift would conform to the street railway schedules.

The station was operated on 315 days during the year and all the water drawn from the Sudbury Reservoir was used for the generation of electric energy, as none was by-passed around the turbines or wasted at the overflow.

On account of the storage available on both services it has been possible to operate the machinery at maximum efficiency most of the time, which accounts for the very high over all efficiency of the station for the year.

On August 21 the work of connecting the power station with the Wachusett-Sudbury transmission line was begun. Another automatic oil switch was installed at the power station and connected with the spare underground cable. Disconnecting switches were also installed on this line at the power station and at the lightning arrester chamber where connection is to be made later with the low-tension side of a 1,500-kilowatt, 66,000 to 13,200-volt transformer which is to be installed by the Edison Electric Illuminating Company just outside of the chamber. Disconnecting switches were also installed on the lines to both of the 750-kilowatt transformers in the power station so that either transformer can now be readily disconnected in case of trouble.

About midnight December 10 the watchman at the station thought there was indication of a fire at transformer No. 1 and opened the emergency drain valve which allowed the oil to flow out quickly

into the underground storage tank, which is buried in the ground outside of the station for use in case of fire. It was later discovered that there was no trouble with the transformer and the oil was filtered and pumped back after it had satisfactorily passed the required break-down tests. This experience showed that the safety devices work satisfactorily and that for use in the future it would be desirable to have a permanent suction pipe extending from the outside storage tank into the station and a ¾-inch pipe has therefore been installed.

The turbines and gate shafts which had begun to show some evidence of rust were scraped and painted with red lead and litharge mixed in linseed oil. This work was done August 25 and 26 and September 1 and 2.

Sparham cement was applied to the concrete roof and stone coping of the lightning arrester chamber to stop a slight leakage which occurred at times.

During a severe electrical storm on July 17 the automatic oil switch on the Hopkinton line was put out of service by the breaking of one of the porcelain insulators, but the damage was promptly repaired, the station being out of service only 6½ hours.

The portion of the 2-inch wrought iron force pipe from the tight cesspool at the station to the leaching cesspool, which could not be laid at satisfactory depth below the surface of the ground, to prevent freezing, was insulated with pitch and ground cork for a distance of 46 feet where it crosses the bridge over the open channel and with slacked lime for an additional distance of 382 feet. A 2-inch service pipe 130 feet in length was laid from the easterly 60-inch supply main to the tight cesspool to furnish water for flushing purposes.

The Sudbury power station statistics are as follows: —

Total energy developed (kilowatt hours),	5,794,230
Energy used at power station (kilowatt hours),	14,166
Available energy (kilowatt hours),	5,780,064
Framingham Reservoir No. 3 service: —	
Water used (gallons),	25,978,700,000
Average head (feet),	65.21
Weston Aqueduct service: —	
Water used (gallons),	18,436,700,000
Average head (feet),	38.54
Energy developed per million foot gallons (kilowatt hours),	2.41
Efficiency of station (per cent.),	76.80

Credit: —			
Energy sold Edison Electric Illuminating Company of Boston, 5,780,064 kilowatt hours at $0.00625,			$36,125 39
Charges: —			
Superintendence,		$1,324 55	
Labor, operating station,		7,490 49	
Repairs and supplies,		671 03	
Alterations and additions: —			
Labor,	$1,839 45		
Apparatus and supplies,	1,720 71		
		3,560 16	
		$13,046 23	
Taxes,		1,010 60	
Administration, general supervision, interest and sinking fund,		5,656 72	
			19,713 55
Profit,			$16,411 84
Cost of available energy per thousand kilowatt hours,			$3.411

Distribution Pumping Service.

The greatest demand so far made on the distribution pumping service occurred during the year as a result of the coldest weather experienced since the works were put into service, which caused an unprecedented use of water at a time when there was great difficulty in obtaining fuel and workmen necessary for operating the works. The maximum daily pumpage at all of the stations was 152,376,600 gallons on February 5 as compared with a previous daily maximum of 142,887,200 gallons pumped in 1903. At that time the entire supply was furnished by pumping while a portion of the supply is now furnished by gravity.

The total quantity of water pumped at the five distribution pumping stations during the year was 33,194,370,000 gallons, which is 9,586,350,000 gallons or 40.61 per cent. more than the quantity pumped in 1917. Of the total quantity of water supplied in 1918 67.86 per cent. was pumped before using and 2.22 per cent. was repumped in order to deliver it at the desired elevation.

The total cost of operating all of the pumping stations for the year 1918 was $186,682.56, which is $54,351.53 more than for the previous year. This increase includes $7,875.81 for labor, $40,152.05

for fuel, $4,893.91 for repairs, $543.38 for oil, waste and packing, and $886.38 for small supplies.

On account of transportation difficulties contractors who had agreed to furnish coal for the pumping stations were unable to do so during the winter and it became necessary to obtain about 1,870 gross tons of semi-bituminous coal through the New England Fuel Administration to keep the pumping stations in operation. Most of this coal was shipped to Boston by water and cost about $10.90 per gross ton or $3.75 more than the all rail coal which our contractor was unable to furnish. During the summer the Fuel Administration furnished about 1,020 gross tons of semi-bituminous coal for reserve storage. Most of this was all rail coal, costing about $7.50 per gross ton in temporary storage bin at the Chestnut Hill pipe yard, and there was an additional expense of about 50 cents per gross ton for transferring it to the pumping station bins as required for use.

Investigations made early in the year showed that we would be unable to contract for a year's supply of coal in the usual manner. After the termination of our 1917 contracts, however, we were able to place orders for 500 gross tons of semi-bituminous coal per month on the basis of the United States Fuel Administrator's price at the mine, plus 17 cents per ton for dealers' commission, and for 3,000 gross tons of anthracite mine screenings on the basis of $2.25 at the mines. Both orders were placed subject to the dealers' ability to deliver the coal. Small quantities of anthracite screenings were also purchased from local coal yards.

The amount and price of the coal received at the pumping stations during 1918 is as follows: —

Dealer and Kind of Coal.	Stations[1] (Amount in Gross Tons).					Cost per Gross Ton in Bins.[4]
	Chestnut Hill No. 1.[1]	Chestnut Hill No. 2.[2]	Spot Pond.[3]	Arlington.[3]	Hyde Park.[3]	
Bituminous.						
E. Russell Norton,	360.15	-	-	-	-	$7 12
Shaftsbury Coal & Coke Co.,	398.97	-	-	-	-	7 18
*New England Fuel Administration,	432.46	-	-	-	-	11 25
*New England Fuel Administration,	196.16	-	-	-	-	7 07
E. Russell Norton,	-	2,468.43	-	-	-	7 36
Shaftsbury Coal & Coke Co.,	-	1,223.08	-	-	-	7 12
*New England Fuel Administration,	-	903.80	-	-	-	10 85
*New England Fuel Administration,	-	1,180.15	-	-	-	7 00
E. Russell Norton,	-	-	815.75	-	-	8 46
*New England Fuel Administration,	-	-	103.61	-	-	11 00
E. Russell Norton,	-	-	-	206.34	-	7 28
Shaftsbury Coal & Coke Co.,	-	-	-	174.37	-	7 17
*New England Fuel Administration,	-	-	-	28.53	-	9 85
Peirce & Winn,	-	-	-	2.50[5]	-	10 36
E. Russell Norton,	-	-	-	-	141.34	7 05
*New England Fuel Administration,	-	-	-	-	41.74	9 17
City Fuel Co.,	-	-	-	-	2.19[5]	11 48
Totals,	1,387.74	5,775.46	919.36	411.74	185.27	-
Average cost: —						
In bins,	$8 42	$7 79	$8 75	$7 43	$7 58	-
On cars,	8 02	7 43	-	7 12	7 37	-
Anthracite Screenings.						
Dexter & Carpenter, Inc.,	691.25	-	-	-	-	$4 94
Dexter & Carpenter, Inc.,	-	3,324.28	-	-	-	4 79
Staples & Bell & New England Fuel & Supply Co.,	-	487.19	-	-	-	5 03
Metropolitan Coal Co.,	-	37.32	-	-	-	5 18
Locke Coal Co.,	-	-	518.97[5]	-	-	5 84
Dexter & Carpenter, Inc.,	-	-	312.14	-	-	6 25
Dexter & Carpenter, Inc., & Staples & Bell,	-	-	-	434.72	-	4 93
Peirce & Winn,	-	-	-	7.16[5]	-	5 60
Dexter & Carpenter, Inc., & Staples & Bell,	-	-	-	-	160.90	5 04
Wm. H. Harlow & Sons, and Roxbury Coal Co.,	-	-	-	-	95.02[5]	5 76
Totals,	691.25	3,848.79	831.11	441.88	255.92	-
Average cost: —						
In bins,	$4 94	$4 82	$5 99	$4 94	$5 31	-
On cars,	4 53	4 48	-	4 75	-	-

* Furnished by various dealers as directed.

[1] Hoisted from cars and wheeled to bins.

[2] 7,836.74 gross tons of coal were dumped from cars into bins, 1,787.51 gross tons were unloaded in storage pile, of which amount 200 gross tons had been transported 300 feet and put into bins at the end of the year.

[3] Unloaded at freight yard, teamed 1⅛ miles, and dumped into bins.

[4] Includes cost of unloading coal from cars and all expenses incidental to the storage of the coal except as otherwise noted.

[5] Delivered at station by truck.

At the end of the year there were 1,534 gross tons of semi-bituminous coal and 1,486 gross tons of anthracite screenings in storage at the pumping stations.

During the past three years the price of Pennsylvania semi-bituminous coal delivered by rail has increased about 75 per cent., from $3.95 to $6.95 per gross ton on cars at the Chestnut Hill station, and

of this \$3.00 increase about \$0.70 is on account of the increase in freight rates. In the same period the price of anthracite screenings has also increased in about the same proportion, from \$2.85 to \$5.00 per gross ton, and of the \$2.15 increase about \$0.75 is on account of the increase in freight rates.

Although coal has not been purchased under specifications since the 1917 contracts expired, the coal received has been sampled and analyzed and the results for 1918 are as follows: —

Kind of Coal.	Number of Samples tested.	British Thermal Units.	Percentage of Volatile Matter.	Percentage of Ash.	Percentage of Moisture.	Percentage of Fixed Carbon.
Davenport, . . .	51	14,502	19.14	8.39	2.65	72.47
Ake Mine, ...	27	13,807	23.92	11.93	4.11	64.15
Miscellaneous, . . .	27	14,008	22.56	10.51	3.60	66.93
Anthracite screenings, . .	68	12,200	8.62	17.16	8.95	74.22

Chestnut Hill Pumping Stations.

At Chestnut Hill pumping station No. 1 the beam on the left hand side of engine No. 1 broke while the engine was in operation on June 24, and repairs were made by using a spare casting which we had on hand and by straightening the connecting rod which was bent when the accident occurred. Later in the year, on September 8, the left hand main crank on this engine cracked and a new forging is now being made at the Atlantic Works. On October 24 the right hand high-pressure piston of engine No. 2 became loose but repairs were completed within a few days. Extensive repairs have been made on boiler No. 4; slight cracks at the edges of the steel sheets where exposed in the furnace have been electrowelded and the brickwork of the furnace has been repaired. Considerable work has also been done in repairing the electric light circuits at this station.

At Chestnut Hill pumping station No. 2 considerable work has been done on the boilers and on the electric light circuits. The electric light plant at this station, which is usually operated for lighting both stations, broke down October 22. Extensive repairs were found to be necessary to put it in satisfactory condition. This work was completed November 22. Both stations were lighted from

the electric light plant at station No. 1 while this work was in progress. On account of the reduced force the heater which was purchased for station No. 2 in 1917 was not installed.

Since September 3 the screenings and bituminous coal burned at station No. 2 have been mixed in the desired proportions as deposited in the bins and better results have been obtained than formerly when the mixing was done as the coal was fired.

At these stations 15,695,300,000 gallons of water were pumped to supply the southern high-service district and the southern extra high-service pumping station. For this service the maximum daily pumpage was 62,532,000 gallons on February 5, and the average daily pumpage was 43,000,800 gallons.

From January 1 to February 6 and from April 6 to the end of the year the entire low-service pumpage was for the southern low-service district. During these periods the entire northern low-service supply, a small portion of the southern low-service supply and the supply for the northern high and northern extra high-service pumping stations were furnished by gravity from the Weston Aqueduct supply mains. From February 6 to April 6 the northern low-service district and the northern high and northern extra high-service pumping stations were supplied by the low-service pumps and the southern low-service supply was furnished by gravity from the Weston Aqueduct supply mains.

On account of the fuel and labor situation it was necessary to operate the boilers in battery most of the time. The cost of operating the individual engines was not determined.

The pumping statistics for 1918 are as follows: —

Station No. 1.

	Engines Nos. 1 and 2.	Engine No. 3.	Engine No. 4.	Totals.
Daily pumping capacity (gallons),	16,000,000	20,000,000	30,000,000	66,000,000
Total quantity pumped (million gallons),	1,538.29	-	284.80	1,823.09
Daily average quantity pumped (gallons),	4,214,500	-	780,300	4,994,800
Bituminous coal used (pounds),	-	-	-	2,793,007
Anthracite screenings used (pounds),	-	-	-	1,501,750
Average lift (feet),	132.94	-	124.05	131 55
Cost of pumping: —				
Labor,	-	-	-	$12,008 61[1]
Fuel,	-	-	-	14,305 90
Repairs,	-	-	-	4,402 86
Oil, waste and packing,	-	-	-	265 12
Small supplies,	-	-	-	525 45
Totals,	-	-	-	$31,507 94
Cost per million gallons pumped,	-	-	-	$17.2827
Cost per million foot gallons,	-	-	-	.1314

[1] Operation and care of station with machinery held in reserve a large portion of the time.

Station No. 2.

	Engines Nos. 5, 6 and 7.	Engine No. 12.	Totals.
Daily pumping capacity (gallons),	105,000,000	40,000,000	145,000,000
Total quantity pumped (million gallons),	13,351.75	13,872.21	27,223.96
Daily average quantity pumped (gallons),	36,580,100	38,006,100	74,586,200
Bituminous coal used (pounds),	-	-	9,756,064
Anthracite screenings used (pounds),	-	-	7,737,469
Average lift (feet),	36.26	122.44	80.17
Cost of pumping: —			
Labor,	-	-	$35,727 67
Fuel,	-	-	54,936 41
Repairs,	-	-	6,978 30
Oil, waste and packing,	-	-	904 75
Small supplies,	-	-	965 79
Total,	-	-	$99,512 92
Cost per million gallons pumped,	-	-	$3.6553
Cost per million foot gallons,	-	-	.0456

On account of the limited capacity of the southern high-service reservoirs and of the use of the Weston Aqueduct supply mains for furnishing considerable water to the low-service districts without pumping, considerable high-service pumping capacity at station No. 1 and low-service pumping capacity at station No. 2 is held in reserve for emergency service; the stations are not usually operated at full capacity and the efficiency of the machinery is reduced somewhat under these conditions.

The electric light service for both stations was furnished from station No. 1 from October 22 to November 22 and from station No. 2 during the remainder of the year.

Spot Pond Pumping Station.

The installation of a steam jet ash conveyor and of an 18-inch Pelton water wheel and 2½-kilowatt generator for electric lighting service when the steam plant is not in operation, which was begun in 1917, has been completed, and this equipment has given satisfactory service. In connection with the installation of the steam jet ash conveyor a second-hand steel tank with hopper bottom, 6 feet in diameter and 10 feet long over all, was erected on a steel framework, lined with cement mortar and used for the storage of ashes. The tank was arranged so that trucks and teams could be backed under the hopper and loaded quickly and the ashes were removed in this manner from time to time as required.

A Venturi meter installed on the boiler feed line early in the year in connection with the reserve Blake & Knowles simplex 6½-inch x 4⅛-inch x 8-inch boiler feed pump, which was installed late in 1917, remedies an unsatisfactory condition which formerly existed.

All of the water supplied to the northern high-service district during 1918 was pumped at this station, also an emergency supply of 2,511,000 gallons between January 24 and 29 and of 433,000 gallons on November 23 and 24, which was furnished to the town of Marblehead by the town of Swampscott while breaks in the force main of the Marblehead Water Works were being repaired.

The northern high-service pumping statistics for 1918 are as follows: —

Total quantity pumped (gallons),	3,474,700,000
Daily average quantity pumped (gallons),	9,520,000
Bituminous coal used (pounds),	1,951,518

Anthracite screenings used (pounds),	1,995,279
Average lift (feet),	131.82
Engine No. 8 operated (hours),	331
Engine No. 9 operated (hours),	3,973
Quantity pumped by Engine No. 8 (gallons),	142,540,000
Quantity pumped by Engine No. 9 (gallons),	3,332,160,000

Cost of pumping: —	
Labor,	$11,977 86
Fuel,	13,890 64
Repairs,	4,770 48
Oil, waste and packing,	530 80
Small supplies,	440 26
Total for station,	$31,610 04
Cost per million gallons pumped,	$9.0972
Cost per million foot gallons,	.0690

The pumps at this station are operated about 12 hours per day, the boilers being maintained with banked fires at other times, and the machinery cannot be operated at maximum efficiency under these conditions.

Arlington Pumping Station.

All of the water supplied to the northern high-service district during the year was pumped at the Arlington station from the northern low-service mains. The new steam turbine-driven centrifugal pumping unit, which was installed mainly for a reserve and for use at times of unusually large consumption, was put into service on April 8, and the new boiler was put into service on November 19. With these improvements the possibility of an interruption in the service at this station is extremely remote. The electric light plant was overhauled and repaired.

The northern extra high-service pumping statistics for 1918 are as follows: —

Total quantity pumped (gallons),	376,620,000
Daily average quantity pumped (gallons),	1,031,800
Bituminous coal used (pounds),	884,414
Anthracite screenings used (pounds),	814,055
Average lift (feet),	282.32
Engine No. 10 operated (hours),	7,701
Engine No. 11 operated (hours),	2
Engine No. 15 operated (hours),	146

Quantity pumped by Engine No. 10 (gallons),	367,680,000
Quantity pumped by Engine No. 11 (gallons),	110,000
Quantity pumped by Engine No. 15 (gallons),	8,830,000

Cost of pumping: —

Labor,	$7,397 53
Fuel,	4,929 06
Repairs,	1,203 93
Oil, waste and packing,	198 19
Small supplies,	262 24
Total for station,	$13,990 95
Cost per million gallons pumped,	$37.1487
Cost per million foot gallons,	.1316

Hyde Park Pumping Station.

All of the water supplied to the southern extra high-service district during 1918 was repumped at the Hyde Park pumping station from the southern high-service mains. Only the usual minor repairs have been necessary during the year.

The southern extra high-service pumping statistics for 1918 are as follows: —

Total quantity pumped (gallons),	296,000,000
Daily average quantity pumped (gallons),	811,000
Bituminous coal used (pounds),	321,616
Anthracite screenings used (pounds),	470,602
Average lift (feet),	137.23
Engine No. 13 operated (hours),	3,214
Engine No. 14 operated (hours),	1,801
Quantity pumped by Engine No. 13 (gallons),	173,060,000
Quantity pumped by Engine No. 14 (gallons),	122,940,000

Cost of pumping: —

Labor,	$7,069 20
Fuel,	2,245 34
Repairs,	287 56
Oil, waste and packing,	189 96
Small supplies,	268 65
Total for station,	$10,060 71
Cost per million gallons pumped,	$33.9889
Cost per million foot gallons,	.2477

The pumps at this station are operated about 11 hours per day, the boilers being maintained with banked fires at other times and the machinery cannot be operated at maximum efficiency under these conditions.

Additional information regarding the operation of the pumping engines at the various stations is given in tables in Appendix No. 2.

Distribution Reservoirs.

The locations, elevations and capacities of the distribution reservoirs of the Metropolitan Water Works are shown by the following table: —

Distribution Reservoirs and Locations.	Elevation of High Water.[1]	Capacity in Gallons.
Low Service:—		
Spot Pond, Stoneham and Medford,	163.00	1,791,700,000
Chestnut Hill Reservoir, Brighton District of Boston,	134.00	300,000,000
Weston Reservoir, Weston,	200.00	200,000,000
Mystic Reservoir, Medford,	157.00	26,200,000
Northern High Service: —		
Fells Reservoir, Stoneham,	271.00	41,400,000
Bear Hill Reservoir, Stoneham,	300.00	2,450,000
Northern Extra High Service: —		
Arlington Standpipe, Arlington,	442.00	550,000
Southern High Service: —		
Fisher Hill Reservoir, Brookline,	251.00	15,500,000
Waban Hill Reservoir, Newton,	264.50	13,500,000
Forbes Hill Reservoir, Quincy,	192.00	5,100,000
Forbes Hill Standpipe, Quincy,	251.00	330,000
Southern Extra High Service: —		
Bellevue Reservoir Steel Tank, West Roxbury District of Boston,	375.00	2,500,000
Total,	–	2,399,230,000

[1] Elevation in feet above Boston City Base.

By arrangement with the city of Chelsea a portion of the maintenance of its reservoir on Powder Horn Hill is assumed by the department, and the reservoir is used by the department when necessary in connection with the supplying of water to the northern high-service district. This reservoir has a capacity of 1,000,000 gallons with high-water line at elevation 196.6. The reservoir was

in service until February 1, when it was drawn down on account of leakage through the embankment, and a crack was found between the original brick lining and the new concrete lining which was placed on the upper portion of the inner slope in 1904. The water in the reservoir was kept below this crack until November, when the reservoir was drained. During November and December the loose material was dug out of the crack, which then varied from 2 to 7 inches in width, and repairs were made with a mixture of Barber Positive Seal Asphalt and pea stone applied hot. After the material had cooled it was thoroughly rammed and sealed with a brush coat of asphalt. The total cost of the work, which was not entirely completed at the close of the year, will be about $400.

Water is delivered into the Chestnut Hill Reservoir from the storage reservoirs by gravity and is pumped from that reservoir for the low-service and southern high-service districts.

Water is delivered from the Sudbury Reservoir through the Weston Aqueduct by gravity and is then supplied to the low-service works through the Weston Aqueduct supply mains by gravity.

Water for the northern high-service district is pumped from Spot Pond to the Fells and Bear Hill reservoirs. For the northern extra high-service district water is pumped from the low-service pipe lines to the steel tank at Arlington Heights and for the southern extra high-service water is pumped from the southern high-service pipe lines to the Bellevue Reservoir.

Weston Reservoir.

At the Weston Reservoir the inlet chamber, open channel, reservoir and screen chamber and the terminal chamber on the lower Weston Aqueduct were cared for. The screens, beaches, lawns, walks, driveways, drains and fences were given the necessary attention, but on account of scarcity of labor no special work was attempted. The ironwork in the screen and channel chambers, the stop-planks in the screen chamber and the iron fences at the Ash Street bridge and the terminal chamber were painted.

Chestnut Hill, Fisher Hill and Waban Hill Reservoirs.

The work of caring for the gate-houses and screens and the shrubs, walks, drives and grounds at the Chestnut Hill, Fisher Hill and Waban Hill reservoirs was attended to with a smaller force than

usual because of the scarcity of labor. The Bradlee basin of the Chestnut Hill Reservoir and the Fisher Hill and Waban Hill reservoirs were in service throughout the year. The Lawrence basin of the Chestnut Hill Reservoir was out of service from May 13 to June 19.

The ironwork, woodwork and screens at all the gate-houses have been painted and repaired where necessary. Some of the iron pipe rails and the concrete posts of the fence built in 1916 along Beacon Street on the southerly shore of the Bradlee basin have been repaired at three points where injured by automobiles.

The work of installing wires for electric lights, private telephone and watchmen's clock circuits in underground conduits between the buildings at Chestnut Hill Reservoir has been completed. All wires at this place are now underground. In connection with this work a 1½-inch iron pipe was laid from pumping station No. 1 under Beacon Street to effluent gate-house No. 2 so that steam will be available for removing anchor ice in cold weather if necessary.

The driveway has been resurfaced where disturbed by the construction of the new garage and shrubs have been set out at the garage and other points where required to replace dead or injured stock. Over 500 shrubs of various kinds and 15 Douglass spruce trees 4 to 5 feet high were used for this work.

Spot Pond, Fells and Bear Hill Reservoirs.

The gate-houses, walks, shrubs and grounds have received the usual attention. The gates have been operated and the screens cleaned as required. The row boat and motor boat at Spot Pond have been painted and varnished. The engine in the motor boat was overhauled and the boat-house and tool-house painted. Electric light fixtures have been installed in the department house at Spot Pond and the interior finish has been painted. About 400 linear feet of 2-inch fibre duct has been laid underground between the house, barn and pumping station and a No. 8 twin-wire lead sheathed electric light cable has been installed.

Bellevue and Forbes Hill Reservoirs.

Bellevue Reservoir has been in use throughout the year. The stairway and overflow pipe were cleaned and painted with black varnish. At Forbes Hill the steel tank has been in regular use all

the year and the reservoir has been held full of water for emergency use. The iron stairs leading to the top of the tower were scraped and painted and the interior of the gate chamber has been cleaned and painted. The work of setting fence posts on the south side of the lot has been continued but no wire has been strung on account of scarcity of labor. A slight leak developed in the concrete wall of the gate-house early in the year but has not changed materially during the year.

Arlington and Mystic Reservoirs.

The Arlington standpipe has been in use throughout the year. As it is planned to replace this standpipe with a larger one before many years the painting of the steelwork has been deferred. The grounds about the standpipe have been cared for as usual by the town of Arlington, by agreement.

The Mystic Reservoir has not been in service during the year but was kept full of water for emergency use. Some minor repairs were made to the gate-house and the concrete walk on top of the embankment. On March 18 Tufts College was granted permission to use the reservoir embankments in connection with the instruction of students for military service.

Mystic Lake, Conduit and Pumping Station.

As these structures are not now used for water supply purposes they have been given only the necessary attention to keep them in repair. The elevation of the water in Mystic Lake has been regulated as required and minor repairs were made at the bridge and in the gate-house near the dam.

Repairs begun last year at the department house and stable near the pumping station were practically completed at the close of the year.

On March 23 Tufts College was granted permission to use the old pumping station for training men for aviation service.

Grounds at Arlington and Hyde Park Pumping Stations.

The lawns, shrubs, driveways and grounds at the Arlington and Hyde Park pumping stations have been kept in good condition. The fence at the Hyde Park station has been repaired and painted.

The side track at the Arlington station has been repaired by the Boston & Maine Railroad at a cost of $77.11.

Protection of Water Supply in Distribution Reservoirs.

Special watchmen were employed at the Chestnut Hill, Fells, Mystic and Bear Hill reservoirs and at Spot Pond, as required during the year, to prevent violation of the sanitary rules and regulations, at a cost of $1,483.04.

Distribution Pipe Lines.

The length of distribution pipe lines owned and operated by the department at the close of the year is 124.27 miles, an increase of 1.93 miles during the year. In connection with the maintenance of the pipe lines they have been regularly patrolled and the work of municipalities and public service corporations in the vicinity of the pipe lines has been inspected. The location of each valve chamber has been plainly stenciled on objects along the line so that valves can be readily found when desired. The valves have been kept in good working condition, the valve chambers were cleaned and the frames and covers were regulated to conform to the grades of the streets where necessary. The covers over important valves were covered with salt during cold weather to keep them free from ice.

Low-service Mains in East Boston.

In September, on account of increased activity due to the war, the Boston & Lockport Block Company acquired the property of the city of Boston located east of its premises, between Condor Street and Chelsea Creek, East Boston, for the purpose of enlarging its plant. In connection with this development the Company desired to fill in the portion of the land in which the department maintains two 24-inch water mains, under an easement acquired from the city in 1900, and was granted permission to do so on condition that the pipes should be raised, that the department employees should do any portion of the work deemed necessary to obtain satisfactory results and that the entire cost of the work should be paid by the Company.

On account of the soft mud and silt at this place the pipe lines were originally laid on a pile foundation. The work of raising the pipes was begun September 28. Two 10-inch spruce piles were driven at each pipe length, one on each side of the pipe and about 5 feet on centres and 2 feet back of the bell of the pipe. About half of the piles were driven from a lighter and the others were

driven from a land machine. The piles varied from 20 to 40 feet in length and were driven from 10 to 30 feet below the surface of the mud. The tops of the piles were left at least 10 feet above the top of the pipes and temporary caps were bolted near the top of the piles to support the lifting screws and slings with which the pipe lines were raised for a maximum distance of about 6 feet. The pipe lines were raised in five sections, the longest being 330 feet in length. After the pipes were raised two permanent 6-inch x 12-inch hard pine girder caps were bolted in place at each pile bent to support the pipes. The screws and slings were then removed and the top portion of the piles were cut off.

The easterly line was raised for a length of 451 feet and the westerly line for a length of 456 feet southerly from the bulkhead line at Chelsea Creek, one line being kept in service while the other was being raised, with the exception of a few hours while the work of capping and connecting the lines was in progress. At the bulkhead line the connection of the pipes which were not raised with the pipes which were raised was made by using two $\frac{1}{16}$ curves in each line. The work of cutting and making up the lines and of recalking the joints was done by the department force; the rest of the work was done by the Company.

The work was greatly delayed by lack of men and other causes and at the end of the year although both lines had been raised the easterly line had not been connected at the southerly end so that it could be put into service and only slight progress had been made in filling around the pipes.

In connection with this work a slight relocation of our right of way from Condor Street to the pipe lines is to be made by agreement with the Company.

Pipe Bridges.

Minor repairs were made to pipe bridges over the Boston & Maine Railroad at College Avenue in Medford and Walnut Street in Somerville, also to the bridges over the Pines River at the Saugus–Revere boundary line and over the Saugus River at the Saugus–Lynn boundary line.

All of the pipe boxes are in fair condition with the exception of the one at Chelsea north bridge over the Mystic River, at Chelsea, and the Walnut Street bridge over the Boston & Maine Railroad in Somerville, which should be repaired during the coming season.

Pipe Yards.

Minor repairs were made at the office, carpenter shop and long shed at the Chestnut Hill pipe yard. During the extreme cold weather the pipes of the heating system on the second floor of the building at the Glenwood pipe yard froze and burst. They were removed and pipes leading to the second floor were capped. A radiator was installed in one room on the second floor for use until permanent repairs are made.

Meters, Regulating Valves and Recording Pressure Gages.

There are now 69 Venturi meters varying in size from 6 inches to 60 inches in diameter; 7 Hersey detector meters; 3 Hersey disc meters and 1 Hersey torrent meter connected with the distribution mains, which, with the exception of 9 of the Venturi meters, were used for measuring the water supplied to the various municipalities in the Metropolitan Water District.

In connection with the operation of these meters two men were employed continuously during the year and some additional labor was furnished for this work from time to time as required. The Venturi meter registers were read and the clocks wound twice each week, and they were given such additional attention as was necessary to keep them in repair and operating satisfactorily.

There are now 8 pressure regulating valves installed on the distribution mains for reducing the pressure of water supplied to portions of Chelsea, East Boston and Hyde Park, and to Nahant, Revere, Swampscott and Winthrop. These valves have received the usual attention and have controlled the pressures in a satisfactory manner.

Recording pressure gages have been maintained at 20 stations on the Metropolitan Water Works, and the table in Appendix No. 2, showing the elevation of the hydraulic grade line in feet above Boston city base at 17 of these stations for each month during the year, has been prepared from the charts.

The service pipes leading to the recording gages at Malden City Hall and Mystic Reservoir froze during the cold weather in January and considerable time was spent in thawing them. On account of a leak on the service pipe to the recording gage at Lex-

ington Town Hall it was abandoned and a new ⅝-inch lead pipe was laid in a 4-inch x 4-inch box filled with slaked lime from the Town Hall to the sidewalk, where a connection was made with an abandoned lead service pipe of the Lexington Water Works. On account of the cold weather and discontinuance of heat at the Somerville Public Library the recording gage at this place was shut off on February 7 and was not turned on again until May 3.

Breaks and Leaks.

There were two breaks in the distribution mains during the year. The first occurred June 7 in the 12-inch northern high-service main at Atlantic Avenue near Belle Isle inlet, in Revere, and was caused by electrolysis. A hole about 2 inches in diameter was found on the bottom of one of the pipes. This pipe was removed and a new pipe laid. The pipe line was out of service from 1.30 P.M. June 7 to 12.15 A.M. June 8. On account of the location of the break very little damage was done by the water. The repairs cost $151.98. The second break occurred Sunday, September 15, in the 30-inch northern high-service main at Cross Street near Main Street, in Malden. The break occurred about 5.45 A.M. and the water was shut off shortly after 7 A.M. Repairs were started at once, the broken pipe was removed and a new pipe laid and the line put into service again at 7 P.M. The water from this break did considerable damage to streets in the vicinity. Several catch basins were filled with gravel and the water entered nine cellars through basement windows and doorways and rose to a depth of from a few inches to 2½ feet. There was also some damage to lawns and gardens in the vicinity. During the time that the line was out of service the consumption in the high-service districts of Everett, Chelsea and East Boston, and the entire consumption in Revere, Winthrop, Swampscott and Nahant was supplied from local standpipes and reservoirs and a small quantity of water which was by-passed around the break through the local pipes in Malden. The repairs cost $566.57.

Emergency Pipe Line Service.

The two ¾-ton auto trucks, equipped with special bodies and gate operating attachments, put into service in 1917 for operating valves quickly in case of emergency, have been in service during the entire

year. One of the trucks is stationed at the Chestnut Hill pipe in Brighton for use on the southern portion of the distribution system and the other is stationed at the Glenwood pipe ya Medford for use on the northern portion of the pipe system. are kept on duty ready to operate the trucks in case of emer at any time during the day or night.

Consumption of Water.

The total quantity of water furnished to the 18 municip supplied from the Metropolitan Water Works during the ye measured by the water works meters was 47,363,860,000 g which is equivalent to an average consumption of 129,764,00 lons per day. On the basis of an estimated population of 1,2 this is equivalent to a consumption of 105 gallons per capita pe

By reference to the accompanying diagram it may be seen since 1915 the consumption of water has increased materially withstanding the installation of additional meters. The incre consumption during 1918 is 19,731,700 gallons per day or 17.9 cent. of the consumption during the previous year, and the inc in per capita consumption is 15 gallons per day or 16.67 per This increase has been due to the unusual industrial activity in nection with the war and to the unprecedented cold winter, and therefore reasonable to expect a material decrease in consum with a return to normal conditions.

It is of interest to note that although 72.47 per cent. of the se pipes in the Metropolitan Water District are now equipped meters, more than half of the increase in consumption durin past year is due to intentional waste of water during Jan February and March to prevent freezing of service pipes. F entire week in February the consumption averaged 171,09 gallons per day as compared with an average consumption of 085,000 gallons per day for a week in December when the mini use of water occurred.

The extent to which the frost penetrated into the ground i dicated by the fact that more than 11,000 service pipes and main pipes were frozen; over 1,500 leaks were discovered and 15,000 meters were removed in the Metropolitan Water Di during the winter by the local water departments.

The average daily consumption of water in each of the municipalities supplied from the Metropolitan Water Works during 1917 and 1918, as measured by the Metropolitan Water Works meters, is as follows: —

	Estimated Population, 1918.	Average Daily Consumption.				
		1917.		1918.		Increase in Gallons.
		Gallons.	Gallons per Capita.	Gallons.	Gallons per Capita.	
Arlington,	16,910	997,100	61	1,290,300	76	293,200
Belmont,	9,330	474,800	53	577,700	62	102,900
Boston,	790,330	82,073,200	106	94,634,000	120	12,560,800
Chelsea,	47,570	3,188,500	69	3,501,200	74	312,700
Everett,	40,700	3,033,000	76	3,365,800	83	332,800
Lexington,	5,900	426,700	74	494,600	84	67,900
Malden,	52,150	2,419,300	47	3,254,700	62	835,400
Medford,	34,600	1,641,300	49	2,161,200	62	519,900
Melrose,	17,870	902,900	51	1,180,600	66	277,700
Milton,	9,250	375,000	41	434,500	47	59,500
Nahant,	1,530	155,300	105	228,200	149	72,900
Quincy,	44,200	2,706,800	63	4,632,100	105	1,925,300
Revere,	29,350	1,615,400	58	1,975,500	67	360,100
Somerville,	92,930	6,676,100	73	7,433,200	80	757,100
Stoneham,	7,760	531,300	69	617,700	80	86,400
Swampscott,	7,960	503,800	65	606,100	76	102,300
Watertown,	18,520	1,584,600	89	2,434,700	131	850,100
Winthrop,	14,600	727,200	52	941,900	65	214,700
District,	1,241,460	110,032,300	90	129,764,000	105	19,731,700

This table shows that there was an increase in consumption in every city and town in the District. On account of the magnitude of the war industries in Quincy and Watertown the percentage of increase in consumption is much greater in these places than in the other municipalities. The consumption by districts in 1918 as compared with 1917 is as follows: —

	Gallons per Day, 1918.	Increase from 1917.	
		Gallons per Day.	Percentage.
Southern low-service district, embracing the low-service district of Boston, with the exception of Charlestown and East Boston, .	46,838,000	4,088,900	9.56
Northern low-service district, embracing the low-service districts of Somerville, Chelsea, Malden, Medford, Everett, Arlington, Charlestown and East Boston, ...	26,428,300	4,010,000	17.89
Southern high-service district, embracing Quincy and Watertown, the high-service districts of Boston, and portions of Belmont and Milton, ...	44,631,800	9,457,400	26.89
Northern high-service district, embracing Melrose, Revere, Winthrop, Swampscott, Nahant and Stoneham, and the high-service districts of Somerville, Chelsea, Malden, Medford, Everett and East Boston, ...	10,001,500	1,877,100	23.10
Southern extra high-service district, embracing the higher portions of Hyde Park, Milton and West Roxbury, ...	793,600	105,200	15.28
Northern extra high-service district, embracing Lexington and the higher portions of Arlington and Belmont, ...	1,070,800	193,100	22.00
Totals, ...	129,764,000	19,731,700	17.93

Installation of Meters on Service Pipes.

Chapter 524 of the Acts of the year 1907, as amended by chapter 177 of the Acts of the year 1909, requires that in municipalities supplied with water from the Metropolitan Water Works meters shall be set each year on all new service pipes and on 5 per cent. of all service pipes that were without meters on December 31, 1907, and that it shall be the duty of the Metropolitan Water and Sewerage Board to supervise and promote the enforcement of the provisions of this act.

By the provisions of chapter 269 of the Special Acts of the year 1917 and of chapter 45 of the Special Acts of the year 1918 the city of Boston is relieved from the requirement that meters shall be set each year on 5 per cent. of all services that were not equipped with meters on December 31, 1907, from April 10, 1917, to April 10, 1919.

Information regarding the installation of meters on service pipes by the municipalities supplied with water from the Metropolitan Water Works to December 31, 1918, is given in the table on page 109. From this table it may be seen that the total number of meters set on both old and new service pipes since 1907 in each of the municipalities with the exception of the city of Malden and the town of Nahant is equal to or exceeds the total number of meters required by the statute to be set to December 31, 1918, although there has been some departure from an exact compliance with the law in certain years.

City or Town.	Number of Meters required to be set on Old Services Each Year.	Meters set on Old Services.						Number of Meters required to be set on Old Services to December 31, 1918.	New Services.						Services in Use December 31, 1918.	Meters in Use December 31, 1918.	Per Cent. of Services metered December 31, 1918.
									Installed.			Equipped with Meters.					
		1908 to 1910, inclusive.	1911 to 1915, inclusive.	1916.	1917.	1918.	Totals.		1908 to 1917, inclusive.	1918.[1]	Totals.	1908 to 1917, inclusive.	1918.[1]	Totals.			
Arlington,	55	227	737	-	-	-	964	605	1,368	68	1,436	1,395	68	1,463	3,171	3,171	100.00
Belmont,	-	-	-	-	-	-	-	-	1,018	28	1,046	1,018	28	1,046	1,755	1,755	100.00
Boston,	4,276	11,068	29,424	5,802	1,247	9	47,550	38,280[2]	16,546	243	16,789	13,077	309	13,386	105,458	63,187	59.92
Chelsea,	240	1,733	1,266	2	1	1	3,003	2,640	1,144	18	1,162	1,117	18	1,135	5,194	5,184	99.81
Everett,	252	870	1,211	237	223	256	2,797	2,772	953	25	978	893	25	918	6,043	3,811	63.06
Lexington,	32	239	300	19	55	-	613	352	554	23	577	529	33	562	1,264	1,264	100.00
Malden,	14	113	7	-	-	-	120	154	1,187	66	1,253	1,091	114	1,205	8,192	7,970	97.29
Medford,	179	3,339	195	1	103	-	3,638	1,969	2,442	58	2,500	2,484	58	2,542	6,639	6,639	100.00
Melrose,	119	2,574	17	1	-	3	2,595	1,309	800	32	832	985	35	1,020	4,199	4,380	100.00
Milton,	-	-	-	-	-	-	-	-	798	29	827	798	29	827	2,055	2,055	100.00
Nahant,	16	96	78	32	5	0	211	176	318	9	327	255	1	256	737	557	75.58
Quincy,	230	814	3,631	16	8	-	4,469	2,530	3,935	287	4,222	3,194	164	3,358	10,248	9,270	90.46
Revere,	138	379	1,192	62	72	10	1,715	1,518	1,905	47	1,952	1,702	47	1,749	4,701	3,619	76.98
Somerville,	411	1,854	2,427	434	163	82	4,960	4,521	2,077	23	2,100	2,214	39	2,253	13,514	10,116	74.86
Stoneham,	65	527	774	1	17	-	1,319	715	306	13	319	306	13	319	1,657	1,649	99.52
Swampscott,	21	434	13	-	-	-	447	231	666	32	698	666	32	698	1,954	1,954	100.00
Watertown,	-	-	-	-	-	-	-	-	1,251	52	1,303	1,353	52	1,405	3,184	3,191	100.00
Winthrop,	100	1,894	18	-	37	-	1,949	1,100	946	15	961	926	15	941	3,031	2,960	100.00
Totals,	6,148	26,161	41,290	6,607	1,931	361	76,350	58,872	38,214	1,068	39,282	34,003	1,080	35,083	182,996	132,732	72.47

[1] The number of new services installed and the number of new services equipped with meters seldom agree for the reason that service pipes are installed but meters are not set until the buildings are permanently occupied.

[2] Chapter 45 of the Special Acts of the year 1918 exempts the city of Boston from setting meters on old service pipes for a period of one year.

During 1918 1,068 service pipes and 1,441 meters were installed in the municipalities supplied from the Metropolitan Water Works, and at the close of the year 182,996 service pipes and 132,732 meters were in use; 72.47 per cent. of all the service pipes had been provided with meters; in nine of the municipalities all of the service pipes were equipped with meters and in two other municipalities over 99 per cent. of the service pipes were equipped with meters.

Water supplied Outside of Metropolitan Water District.

During the year 557,769,000 gallons of water were supplied from the Metropolitan Water Works for use outside the Metropolitan Water District as follows: —

Places supplied.	Total Quantity (Gallons).	Average Quantity (Gallons per Day).	Number of Days on which Water was supplied.	Amounts charged for Water supplied.
Westborough State Hospital, ...	59,767,000	163,700	365	$1,793 01
Town of Framingham: —				
From Sudbury Aqueduct, ...	232,000,000	635,616	365	5,568 00
From Filter-gallery at Farm Pond, . .	196,600,000	538,630	365	377 04
United States Government: —				
Peddock's Island, ...	49,246,000	134,900	365	2,660 81
Portion of town of Saugus, ...	16,377,000	44,900	365	800 00

Protection of Water Works Structures.

Measures which were in effect at the beginning of the year for the protection of the water works structures from irresponsible or malicious persons because of the unsettled conditions were terminated December 1.

Quality of the Water.

The yearly average results of the chemical analyses, made by the State Department of Health since 1892, and of the biological and bacteriological examinations, made in the Metropolitan Water Works laboratory, of water from service taps in Boston since 1898, are given in tables in Appendix No. 2.

Engineering.

In connection with the maintenance of the works the engineering force has made plans, estimates and reports for various projects and improvements; has made record plans of water works lands and structures and surveys and plans for land purchases and takings; has tested meters; made photographs, blue prints and analyses of coal and oil; calculated yields of watersheds; made current meter gagings; kept hydraulic and meteorological records; summarized power station and pumping station records; cared for the recording pressure gages and supervised various operations carried on by the department.

Appended to this report are tables giving additional information relating to the operations of the Metropolitan Water Works for the year 1918 and the usual water works statistics.

Respectfully submitted,

WILLIAM E. FOSS,
Chief Engineer.

Boston, January 2, 1919.

REPORT OF CHIEF ENGINEER OF SEWERAGE WORKS.

To the Metropolitan Water and Sewerage Board.

GENTLEMEN: — The following report of the operations of the Metropolitan Sewerage Works for the year ending December 31, 1918, is respectfully submitted: —

ORGANIZATION.

The Chief Engineer has charge of the design and construction of all new works, and of the maintenance and operation of all the works controlled by the Metropolitan Water and Sewerage Board for removing sewage from the twenty-six municipalities which comprise the Metropolitan Sewerage Districts.

The following assistants have been employed during the year: —

Henry T. Stiff, ...	Division Engineer, in charge of office and drafting room and of the construction work.
Clarence A. Moore, . . .	Assistant Engineer, in charge of maintenance studies and records and of construction work on the North Metropolitan System.
Arthur F. F. Haskell, . . .	Assistant Engineer, in charge of survey work and field work in connection with the Wellesley Extension construction.
Ralph W. Loud, ...	Assistant Engineer, in charge of survey work and field work in connection with the Reading Extension construction.
George W. Wood, ...	Assistant Engineer, on Reading Extension.

In addition to the above, the number of engineering and other assistants employed during the year was 17, which includes 2 superintendents, 2 instrumentmen, 6 inspectors, 2 draftsmen, 3 rodmen and engineering assistants and 2 stenographers.

METROPOLITAN SEWERAGE DISTRICTS.

Areas and Populations.

During the year no changes have been made in the extent of the Metropolitan Sewerage districts.

The populations of the districts, as given in the following table, are based on the census of 1915.

Table showing Ultimate Contributing Areas and Present Estimated Populations within the Metropolitan Sewerage Districts, as of December 31, 1918.

	City or Town.	Area (Square Miles).		Estimated Population.	
North Metropolitan District.	Arlington,	5.20		17,220	
	Belmont,	4.66		9,520	
	Boston (portions of),	3.45		110,990	
	Cambridge,	6.11		113,010	
	Chelsea,	2.24		48,200	
	Everett,	3.34		41,160	
	Lexington,[1]	5.11		4,350	
	Malden,	5.07		52,650	
	Medford,	8.35		35,230	
	Melrose,	3.73		18,020	
	Reading,	9.82		7,780	
	Revere,	5.86		29,990	
	Somerville,	3.96		93,870	
	Stoneham,	5.50		7,800	
	Wakefield,	7.65		13,770	
	Winchester,	5.95		10,830	
	Winthrop,	1.61		14,880	
	Woburn,	12.71		17,000	
			100.32		646,270
South Metropolitan District.	Boston (portions of),	24.96		283,900	
	Brookline,	6.81		37,330	
	Dedham,[1]	9.40		12,100	
	Milton,	12.59		9,350	
	Newton,	16.88		45,650	
	Quincy,	12.56		44,740	
	Waltham,	13.63		32,060	
	Watertown,	4.04		18,830	
	Wellesley,	9.89		7,240	
			110.76		491,200
	Totals,		211.08		1,137,470

[1] Part of town.

METROPOLITAN SEWERS.

Sewers Purchased and Constructed and their Connections.

During the year there has been built .229 of a mile of Metropolitan sewer within the sewerage districts, so that there are now 113.240 miles of Metropolitan sewers. Of this total, 9.642 miles of sewers, with the Quincy pumping station, have been purchased from cities and towns of the districts. The remaining 103.598 miles of sewers and other works have been constructed by the Metropolitan boards.

The locations, lengths and sizes of these sewers are given in the following tables, together with other data referring to the public and special connections with the systems: —

North Metropolitan Sewerage System.

Location, Length and Sizes of Sewers, with Public and Special Connections.

City or Town.	Size of Sewers.	Length in Miles.	Public Connections, December 31, 1918.	Special Connections.	
				Character or Location of Connection.	Number in Operation.
Boston: —					
Deer Island,	4' 0" to 9' 0",	1.653	4	–	–
				Shoe factory,	1
East Boston,	9' 0" to 1' 0",	5.467	25	Middlebrook Wool-combing Co.,	1
				Navy Yard,	8
Charlestown,	6' 7"×7' 5" to 1' 0",	3.292	15	Private building,	1
				Club house,	1
Winthrop,	9' 0",	2.864	13	Fire Department Station,	1
				Private building,	1
				Bakery,	1
				Rendering works,	1
Chelsea,	8' 4"×9' 2" to 15",	5.230	13	Metropolitan Water Works blow-off,	1
				Chelsea Water Works blow-off,	2
				Naval Hospital,	1
				Metropolitan Water Works blow-off,	1
				Cameron Appliance Co.,	1
				Shults-Goodwin Co.,	1
Everett,	8' 2"×8' 10" to 4' 8"×5' 1",	2.925	8	Andrews-Waagatt Co.,	1
				National Metallic Bed Co.,	1
				Linoide Co.,	1
				Factory,	2
				New England Structural Co.,	1
Lexington,	–	–	1	–	–
				Metropolitan Water Works blow-off,	1
Malden,	4' 6"×4' 10" to 1' 0",	5.844[1]	34	Private buildings,	183[2]

[1] Includes 1.84 miles of sewer purchased from the city of Malden.

[2] Mostly buildings connected with sewers formerly belonging to city of Malden but later purchased by the Metropolitan Sewerage Commission in accordance with chapter 215 of the Acts of 1898 and by the Metropolitan Water and Sewerage Board in accordance with chapter 512 of the Acts of 1911 and made parts of the North Metropolitan Sewerage System.

NORTH METROPOLITAN SEWERAGE SYSTEM — *Concluded.*

Location, Length and Sizes of Sewers, with Public and Special Connections — Concluded.

City or Town.	Size of Sewers.	Length in Miles.	Public Connections, December 31, 1918.	Special Connections.	
				Character or Location of Connection.	Number in Operation.
				Private buildings,	115[2]
Melrose,	4′ 6″×4′ 10″ to 10″,	6.099[1]	38	Factory,	1
				Railroad station,	1
				Park Department bath house,	1
				Harvard dormitories,	2
				Slaughter-house,	1
Cambridge,	5′ 2″×5′ 9″ to 1′ 3″,	7.209	45	City Hospital,	3
				Street railway machine shop,	1
				Private buildings,	1
				Factory building,	1
				Tannery,	1
				Slaughter-houses (3),	1
				Car-house,	1
Somerville,	6′ 5″×7′ 2″ to 10″,	3.577	12	Somerville Water Works blow-off,	1
				Street railway power-house,	1
				Stable,	1
				Rendering works,	1
				Railroad scale pit,	1
				Armory building,	1
Medford,	4′ 8″×5′ 1″ to 10″,	5.713	24	Private buildings,	9
				Stable,	1
				Police substation,	1
				Tanneries,	6
				Private buildings,	8
				Gelatine factory,	1
				Watch-hand factory,	1
Winchester,	4′ 6″ to 1′ 3″,	9.470	27	Stable,	1
				Railroad station,	1
				Felt works,	1
				Town Hall,	1
				Bay State Saw & Tool Co.,	1
				Whitney Machine Co.,	1
Stoneham,	1′ 3″ to 10″,	0.010	4	–	–
Woburn,	1′ 10″×2′ 4″ to 1′ 3″,	0.933	3	Glue factory,	1
				Private buildings,	159[4]
Arlington,	1′ 6″ to 10″,	3.520[3]	43	Railroad station,	1
				Car-house,	3
				Post office,	1
Belmont,[5]	–	–	3	–	–
Wakefield,[5]	3′ 0″,	0.086	1	–	–
Revere,	4′ 0″ to 15″,	0.136	3	–	–
Reading,	–	–	–	–	–
		64.028[6]	316		547

[1] Includes .736 of a mile of sewer purchased from the city of Melrose.

[2] Mostly buildings connected with a sewer formerly belonging to the city of Melrose but later purchased by the Metropolitan Sewerage Commission in accordance with chapter 414 of the Acts of 1896 and with a sewer extension built in accordance with chapter 436 of the Acts of 1897 by the Metropolitan Sewerage Commission as an outlet for part of the town of Stoneham and made parts of the North Metropolitan Sewerage System.

[3] Includes 2.631 miles of sewer purchased from the town of Arlington.

[4] Mostly buildings connected with a sewer formerly belonging to the town of Arlington but later purchased by the Metropolitan Sewerage Commission in accordance with chapter 520 of the Acts of 1897 and made a part of the North Metropolitan Sewerage System.

[5] The Metropolitan sewer extends but a few feet into the town of Belmont.

[6] Includes 2.787 miles of Mystic Valley sewer in Medford, Winchester and Woburn, running parallel with the Metropolitan sewer.

South Metropolitan Sewerage System.

Location, Length and Sizes of Sewers, with Public and Special Connections.

City or Town.	Size of Sewers.	Length in Miles.	Public Connections, December 31, 1918.	Special Connections. Character or Location of Connection.	Special Connections. Number in Operation.
Boston: —				Tufts Medical School,	1
				Private house,	1
Back Bay,	6' 6" to 3' 9",	1.500[1]	16	Administration Building, Boston Park Department,	1
				Simmons College buildings,	1
				Art Museum,	2
Brighton,	5' 9"×6' 0" to 12",	6.010[2]	15	Abattoir,	3
				Chocolate works,	2
				Machine shop,	1
Dorchester,	3'×4' to 2' 6"×2' 7",	2.870[3]	13	Paper Mill,	1
				Private buildings,	3
				Edison Electric Company Station,	1
				Mattapan Paper Mills,	1
Hyde Park,	10' 7"×11' 7" to 4' 0"×4' 1",	4.527	18	Private buildings,	2
				Fairview Cemetery buildings,	1
Roxbury,	6' 6"×7' to 4' 0",	1.430	–	–	–
				Caledonia Grove buildings,	1
West Roxbury,	9' 3"×10' 2" to 12",	7.642	16	Parental School,	1
				Lutheran Evangelical Church,	1
				Private buildings,	4
Brookline,	6' 6"×7' 0" to 8",	2.540[4]	12	Private building,	2
Dedham,	4'×4' 1" to 2' 10"×3' 1",	2.940	7	Dedham Carpet Mills,	1
Hull,[5]	60" pipe,	0.750	–	–	–
Milton,	11'×12' to 8",	3.600	23	Private buildings,	2
Newton,	4' 2"×4' 9" to 1' 3",	2.911	7	Private houses,	7
Quincy,	11' 3"×12' 6" to 24" pipe,	6.845	14	Metropolitan Water Works blow-off,	1
Waltham,	3' 6"×4' 0",	0.001	1	–	–
				Factories,	2
Watertown,	4' 2"×4' 9" to 12",	0.750[6]	5	Stanley Motor Carriage Co.,	1
				Knights of Pythias building,	1
Needham,[5]	2' 0"×2' 3" to 2' 3"×2' 6",	4.896	–	–	–
Wellesley,[7]	– –	–	–	– –	–
		49.212	147		45

[1] Includes .355 of a mile of sewer purchased from the city of Boston.

[2] Includes .446 of a mile of pipe and concrete sewers built for the use of the city of Boston; also .026 of a mile of sewer purchased from the town of Watertown.

[3] Includes 1.24 miles of sewer purchased from the city of Boston.

[4] Includes .158 of a mile of pipe sewer built for the use of the town of Brookline.

[5] Hull and Needham are not parts of the Metropolitan Sewerage District.

[6] Includes .025 of a mile of sewer purchased from the town of Watertown.

[7] The Metropolitan sewer extends but a few feet into the town of Wellesley.

Information relating to areas, populations, local sewer connections and other data for the Metropolitan Sewerage districts appears in the following table: —

North Metropolitan Sewerage District.

Area (Square Miles).	Estimated Total Population.	Miles of Local Sewer connected.	Estimated Population contributing Sewage.	Ratio of Contributing Population to Total Population (Per Cent.).	Connections made with Metropolitan Sewers.	
					Public.	Special.
100.32	646,270	774.30	579,440	89.7	316	547

South Metropolitan Sewerage District.

110.76	491,200	658.10	372,980	75.9	147	45

Both Metropolitan Sewerage Districts.

211.08	1,137,470	1,432.40	952,420	83.7	463	592

Of the estimated gross population of 1,137,470 on December 31, 1918, 952,420, representing 83.7 per cent., were on that date contributing sewage to the Metropolitan sewers, through a total length of 1,432.40 miles of local sewers owned by the individual cities and towns of the districts.

These sewers are connected with the Metropolitan systems by 463 public and 592 special connections. During the current year there has been an increase of 9.31 miles of local sewers connected with the Metropolitan systems, and 4 public and 6 special connections.

CONSTRUCTION.

NORTH METROPOLITAN SEWERAGE SYSTEM.

Part of Section 76. — Extension to Reading.

The Board entered into a contract with Bruno & Petitti of Boston, Massachusetts, for the construction of about 1,370 feet of sewer extending from the Reading line to the corner of Summer Avenue and Elm Street, Wakefield. Work was commenced under this contract August 3, 1918. The structure consists of 150 feet of 36-inch concrete sewer and 1,220 feet of 24-inch by 27-inch concrete sewer. Average depth of cut 20 feet. Rock was found between Station 26+30 and Station 28+50. The material excavated has been a rather

fine sand which has occasioned difficulty in excavation by reason of the considerable amount of ground water present.

No other attempt at construction has been made on the Reading extension.

SOUTH METROPOLITAN SEWERAGE SYSTEM.

Wellesley Extension.

The Wellesley Extension of the High-level Sewer comprises sections 98 to 106 inclusive. Of these sections 102, 103, 104, 105 and 106 are wholly completed and Section 98 practically so.

Section 98. — Wellesley Extension.

Work on this section was suspended February 15, 1918, owing to the flooded condition of the marshes and was resumed June 11, 1918. During the year 739 feet of sewer have been completed including the river crossing and the connection with the Neponset Valley Sewer. This work has been carried on with great difficulty owing to the nature of the ground and its inaccessibility.

Pile foundation has been placed under all the work constructed during this year.

On December 31, 1918, the section was practically completed, the work remaining being the placing of about 75 yards of concrete, backfilling and clearing up.

Section 99. — Wellesley Extension.

A contract for the completion of 1,685 feet of this section lying mostly in rock tunnel was entered into by the Board, some particulars of which are as follows: —

Date of contract No. 139,	June 7, 1918.
Name of contractor,	Rowe Contracting Company.
Length of section,	1,685 feet.
Average depth of invert of sewer in tunnel below surface,	25 feet.
Average depth of sewer in open cut,	14 feet.
Dimensions of concrete sewer,	33 inches by 36 inches.
Assistant Engineer in charge of construction,	Arthur F. F. Haskell.

Work was begun on this section July 14, 1918.

By private arrangement between the contractor and the owners of the Nickerson Estate a small dwelling house which stood near

the shaft at Station 5+37 was removed to a new location at the contractor's expense. At the present time shafts have been sunk at Stations 1+03, 5+37 and 13+97 and 510 feet of tunnel boring have been completed. No masonry has yet been placed.

The balance of this section, amounting to 1,550 feet, which is to be built in open trench including a river crossing, has not been placed under contract.

SECTIONS 100 AND 101. — WELLESLEY EXTENSION.

These sections, which include about 7,740 feet of 33-inch by 36-inch concrete sewer in trench and river crossing have not been placed under contract owing to insufficient appropriation.

MAINTENANCE.

SCOPE OF WORK AND FORCE EMPLOYED.

The maintenance of the Metropolitan Sewerage System includes the operation of 7 pumping stations, the Nut Island screen-house and 113.24 miles of Metropolitan sewers, receiving the discharge from 1,432.40 miles of town and city sewers at 463 points, together with the care and study of inverted siphons under streams and in the harbor.

The permanent maintenance force at present includes 149 men, of whom 91 are employed on the North System and 58 on the South System. These are subdivided as follows: North Metropolitan System, 57 engineers and other employees in the pumping stations and 34 men, including foremen, on maintenance, care of sewer lines, buildings and grounds; South Metropolitan System, 35 engineers and other employees in the pumping stations and 23 men, including foremen, on maintenance, care of sewer lines, buildings and grounds.

During January and February the water in Boston Harbor was frozen to an extent not known for many years. This shut off the coal deliveries by water from the East Boston, Deer Island and Charlestown pumping stations. At the East Boston and Charlestown pumping stations it was necessary to have coal delivered by teams.

The general scarcity of coal made it necessary for the Board to call upon the State Fuel Administrator to supply our pumping stations. By this means we were able to get a limited supply which often was of very inferior quality. The low duties obtained in the

pumping stations are due to this fact. To help the fuel situation the sewage in the incoming sewers at the pumping stations was allowed to rise from one to two feet higher than normal level in order to reduce lift.

Mr. Henry J. Wright, who had been connected with the Sewerage Works since 1890 and who for twenty-five years was superintendent of the North Metropolitan Sewerage System, was retired because of age limit on August 6, 1918, according to the provisions of chapter 532 of the Acts of 1911.

Mr. Edward Sheehan, employed as oiler at the Ward Street Pumping Station, was injured in the crank pit of the pumping engine at this station on August 23, 1918, and died in the City Hospital a few hours later.

The regular work of this department, in addition to the operation of the pumping stations, has consisted of routine work of cleaning and inspecting sewers and siphons, caring for tide gates, regulators and overflows, measuring flow in sewers, inspection of connections with the Metropolitan sewers, and the care of pumping stations and other buildings and grounds.

In addition to these regular duties other work has been done by this department as follows: —

Deer Island Pumping Station.

The woodwork of the pumping station was painted outside.

It was necessary to clean the 84-inch cast-iron pipes and specials in the new outfall as there was a considerable collection of sand and gravel in the same. This was accomplished by placing closures over the discharge outlets and thereby increasing the current in the pipes.

The temporary outfall at Deer Island used during the construction of the 84-inch cast-iron outfall was flushed and cleaned and sealed at the outer end by means of a cast-iron cover. This cover is held in place at present by two dowels.

All work except the diving was done by maintenance employees.

An arrangement was made with the Public Institutions Department of the city of Boston whereby the ferrying at Shirley Gut is done by employees of that department which greatly reduces the cost to the Commonwealth of the maintenance of this ferry.

East Boston Pumping Station.

A two-story masonry locker for storing pumping station supplies was constructed within the pumping station at the easterly end of the engine room.

The overflow channel on the Chelsea side of the East Boston siphon was cleaned out and the timber work repaired.

Three Metropolitan sewerage manholes on Saratoga Street, East Boston, had to be taken down and rebuilt to accommodate the laying of pavement and sidewalks which were constructed by the Street Department of the city of Boston; the cost of this work to be repaid to the district by the city.

All work was done by maintenance employees.

Charlestown Pumping Station.

It was necessary to take down the brick wall and rebuild the same at the northeast corner of the pumping station owing to disintegration of the mortar by reason of exposure to storm.

A new landing platform at the coal run was constructed.

All work was done by maintenance employees.

Removal of Old Mystic Siphon, Winchester.

The 24-inch siphon which crossed the Aberjona River near Wedgemere Station and which was built by the city of Boston in connection with the construction of the old Mystic Valley Sewer was removed at the request of citizens of Winchester. A connection was made between the old Mystic Valley Sewer and the Metropolitan trunk sewer at Station 4+55. Section 44 of the latter and that part of the old Mystic Sewer between this point and the location of the siphon is discontinued.

All work was done by maintenance employees.

Nut Island Screen-house.

The harbor ice which was of unusual thickness in this vicinity damaged the wharf at Nut Island to such an extent that it was necessary to drive twenty oak piles and do other work of repairs. This was accomplished by G. M. Bryne, Contractor, who furnished piles, machinery and a foreman who worked in conjunction with the maintenance employees.

The stable, locker building, boat house and fences of the stock yard and the railings at the wharf were painted during the year.

Concrete gutters and about 150 feet of concrete fence were constructed at the southerly end of the road leading to Nut Island screen-house.

All work was done by maintenance employees.

Quincy Pumping Station.

The woodwork of this station was cleaned and painted during the year.

All work was done by maintenance employees.

Government Use of Old 24-inch Quincy Force Main.

The sewerage connection of the shipbuilding plant at Squantum, Quincy, with the 24-inch cast-iron force main in Squantum Street, mentioned in last year's report, was put in operation early in 1918. The average discharge through the force main has been at the rate of about 125,000 gallons per 24 hours. This sewage is discharged through the Boston Main Drainage outfall works at Moon Island.

Gasolene in Public Sewers.

The efforts to improve the condition of the Metropolitan sewers in regard to dangers resulting from the introduction of gasolene into the same have been continued throughout the year and have been successful.

An inspector has been employed in this department whose duty it is to visit existing garages and see that the separators are kept in proper condition, also to enforce the regulation concerning the installation of such separators at all newly constructed garages.

During the year 47 new garages and other establishments using gasolene have been connected with the local sewer systems which discharge into the Metropolitan sewers. While the presence of gasolene in the Metropolitan sewers is noted occasionally, the condition has been greatly improved.

The following tables show the particulars in regard to establishments known to be using gasolene and which are connected with the public sewerage systems of the different municipalities in the Metropolitan sewerage districts.

North Metropolitan Sewerage District.

Table showing Number of Places connected with Public Sewers where Gasolene is used and Progress of Work of installing Separators to December 31, 1918.

City or Town.	Number of Places connected with Sewer.	Number of Places originally having Acceptable Separators.	Number of Places where Changes have been made.	Number of New Garages built, 1918.
Arlington,	6	-	3	-
Belmont,[1]	4	-	3	-
Boston: —				
Charlestown District,	22	-	19	3
East Boston District,	22	-	17	5
Cambridge,[2]	95	-	94	5
Chelsea,	22	-	18	4
Everett,	15	-	14	1
Lexington,	-	-	-	-
Malden,	21	-	20	1
Medford,	14	-	13	1
Melrose,	5	-	5	-
Revere,	9	-	3	-
Somerville,	41	8	32	1
Stoneham,	6	-	6	-
Wakefield,	6	-	6	-
Winchester,	14	-	14	-
Winthrop,	4	-	4	-
Woburn,	3	-	3	-
Reading,[3]	-	-	-	-
Totals,	309	8	274	21

[1] Washstand discontinued.
[2] Storer's garage; no separator.
[3] Not yet connected with Metropolitan sewer.

South Metropolitan Sewerage District.

Table showing Number of Places connected with Public Sewers where Gasolene is used and Progress of Work of installing Separators to December 31, 1918.

City or Town.	Number of Places connected with Sewer.	Number of Places originally having Acceptable Separators.	Number of Places where Changes have been made.	Number of New Garages built, 1918.
Boston: —				
Hyde Park District,	14	-	8	-
West Roxbury District,	26	10	16	6
Back Bay District,	48	22	26	-
Brighton District,	50	22	28	7
Dorchester District,	31	20	11	4
Brookline,	63	9	54	3
Dedham,	3	3	-	-
Milton,	1	1	-	-
Newton,	41	18	23	3
Quincy,	15	-	15	1
Waltham,	6	5	1	1
Watertown,	16	3	13	1
Wellesley,[1]	-	-	-	-
Totals,	314	113	195	26

[1] Not yet connected with Metropolitan sewer.

Drainage from Tanneries, Gelatine and Glue Works in Winchester, Woburn and Stoneham.

Four men and a foreman have been employed during a part of the year in flushing and cleaning the Metropolitan sewers through the tannery districts in Winchester, Woburn and Stoneham.

All the tanneries and glue works of the district now have settling tanks of substantial size. This method of treatment has very greatly reduced the amount of sludge material entering the Metropolitan sewers.

The following table gives details of settling tanks introduced to date, showing the operations of same with the amount of sludge collected and removed: —

Table of Semi-fluid Sludge removed from Settling Basins at the Tanneries, Gelatine and Glue Works in Winchester, Woburn and Stoneham, Year ending December 31, 1918.

Location of Basin.	Basin put in Operation.	Inside Measurement of Basin (Feet).	Number of Times cleaned during the Year.		Total Quantity Semi-fluid Sludge removed during the Year (Cubic Yards).
Beggs & Cobb Company, Basin No. 1,[1] .	Jan. 15, 1910	47.0 × 23.0	–	–	–
Beggs & Cobb Company, Basin No. 2,[1] .	May 9, 1910	47.0 × 23.0	–	–	–
Beggs & Cobb Company, Basin No. 3,[1] .	Oct. 10, 1911	51.0 × 26.0	–	–	–
Beggs & Cobb Company, "Rotary Screen Process."[2]	Dec. 12, 1917	–	–[3]	–	172 00
S. C. Parker & Son,[4]	Aug. 1, 1910	48.3 × 23.0	–	–	–
American Hide and Leather Company, Factory D.	Nov. 15, 1910	48.0 × 23.1	8	139 50	1,116.00
Dorington Leather Company, ...	Dec. 10, 1910	47.2 × 23.0	6	106.84	641.04
E. Cummings Leather Company, . . .	Nov. 1, 1910	45.9 × 22.6	6	97.60	585 60
W. P. Fox & Sons, ...	July 12, [illegible]	47.8 × 22.6	13	270.40	3,515 20
Thayer & Foss, ...	Sept. 15, 1910	48.1 × 23.1	4	209.80	839.20
Morris Kaplan,[4]	Jan. 9, 1911	46.8 × 22.9	–	–	–
		4.0 × 4.0	50	1.00	50 00
Van Tassell Leather Company,[4] . .	May 1, 1911	10.2 × 14.5	–	–	–
		48.8 × 19.6	4	103.00	[illegible]
American Glue Company, ...	Oct. 1, 1910	47.1 × 23.0	4	136.36	545 44
J. O. Whitten Company, ...	1902	35.5 × 24.7	22	58.74	1,292.28
		67.2 × 12.0	28	8.50	238 00
Total, ...	–	–	–	–	9,402 76

[1] Basins filled up temporarily.

[2] By permission of the Board, dated July 25, 1917, effluent formerly passing through three settling basins has been conducted through "Riensch-Wurl" screens and is allowed to enter the Metropolitan Sewer by a special 15" branch.

Permission was granted with the provision that all existing connections and settling basins shall be left intact and ready for use if necessary.

[3] Daily, continuous.

[4] Not used in 1918.

North Metropolitan Sewerage System.

Table showing Cities and Towns delivering Sewage to this System; Approximate Miles of Sewers connected; Estimated Populations and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on Such Areas; Ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to Present Total Populations.

[Populations estimated as of December 31, 1918.]

Cities and Towns.	Miles of Local Sewers connected.	Separate or Combined.	Number of Connections with Local Sewers.	Estimated Number of Persons served by Each House Connection.	Estimated Population now contributing Sewage.	Estimated Present Total Population.	Estimated Area now contributing Sewage.	Area ultimately to contribute Sewage.	Ratio of Contributing Population to Present Total Population.	Ratio of Contributing Area to Ultimate Area.
							Sq. Miles.	Sq. Miles.	Per Cent.	Per Cent.
Boston (Deer Island),	.70	Separate,	-	-	520 [1]	520 [1]	-	-	100.0	-
Winthrop,	32.43	Separate,	3,013	4.90	14,760	14,880	1.40	1.61	99.2	87.0
Boston (East Boston),	33.97	Separate and combined,	5,110	13.20	67,450	70,470	1.17	2.18	95.7	53.7
Chelsea,	31.01	Separate and combined,	4,248	10.90	46,300	48,200	1.14	2.24	96.1	50.9
Everett,	48.02	Separate and combined,	5,132	7.00 [2]	35,920	41,160	2.00	3.34	87.3	59.9
Malden,	66.46	Separate,	7,059	6.70 [2]	47,300	52,650	3.14	5.07	89.8	61.9
Melrose,	39.17	Separate,	3,358	4.50 [2]	15,110	18,020	1.88	3.73	83.9	50.4
Boston (Charlestown),	21.69	Separate and combined,	5,438	7.30	39,700	40,000	0.67	1.27	99.2	52.8
Cambridge,	155.24	Separate and combined,	16,815	6.65	111,820	113,010	5.05	6.11	98.9	82.7
Somerville,	101.57	Separate and combined,	16,002	5.75	92,010	93,870	3.50	3.96	98.0	88.4
Medford,	65.21	Separate,	6,136	5.60 [2]	34,360	35,230	3.16	8.35	97.5	37.8
Winchester,	32.18	Separate,	2,004	5.20 [2]	10,420	10,830	1.53	5.95	96.2	25.7
Woburn,	15.52 [3]	Separate,	1,248	5.80 [2]	7,240	17,000	1.02	12.71	42.6	8.0
Stoneham,	13.46	Separate,	954	4.70 [2]	4,480	7,800	0.70	5.50	57.4	12.7
Arlington,	32.32	Separate,	2,375	5.80 [2]	13,780	17,220	1.97	5.20	80.0	37.9
Belmont,	22.00	Separate,	1,323	6.00 [2]	8,430 [4]	9,520	1.34	4.66	88.6	28.8
Wakefield,	14.36	Separate,	820	5.60 [2]	4,590	13,770	0.60	7.65	33.3	7.8
Lexington,	6.51	-	69	4.30	300	4,350	0.23	5.11	6.9	4.5
Revere,	42.48	Separate,	3,669	6.80	24,950	29,990	2.06	5.86	83.2	35.5
Reading, [5]	-	-	-	-	-	7,780	-	9.82	-	-
Totals,	774.30	-	84,773	6.80	579,440	6:6,270	32.58	100.32	89.7	32.5

[1] Estimated by Supt. Henry A. Higgins of the institution on Deer Island.

[2] Estimated from assessors' statement of the number of houses in the city or town on April 1, 1918, and the population from census of 1915.

[3] Exclusive of Mystic valley sewer and tanneries.

[4] Including 2 connections with McLean Hospital, having an estimated population of 489.

[5] Reading not connected.

South Metropolitan Sewerage System.

Table showing Cities and Towns delivering Sewage to this System; Approximate Miles of Sewers connected; Estimated Populations and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on Such Areas; Ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to Present Total Populations.

[Population estimated as of December 31, 1918.]

Cities and Towns.	Miles of Local Sewers connected.	Separate or Combined.	Number of Connections with Local Sewers.	Estimated Number of Persons served by Each House Connection.	Estimated Population now contributing Sewage.	Estimated Present Total Population.	Estimated Area now contributing Sewage.	Area ultimately to contribute Sewage.	Ratio of Contributing Population to Present Total Population.	Ratio of Contributing Area to Ultimate Area.
							Sq. Miles.	Sq. Miles.	Per Cent.	Per Cent.
Boston (Back Bay), .	26.54	Separate and combined,	1,866	21.30	39,750	40,100	1.15	1.61	99.1	71.4
Boston (Brighton), .	63.38	Separate and combined,	4,017	10.10	40,570	43,580	3.20	3.74	93.1	85.6
Brookline, . . .	74.82	Separate and combined,	4,955	7.45	36,910	37,330	3.65	6.81	98.9	53.6
Newton, . . .	128.37	Separate, . . .	7,633	5.50[1]	41,980	45,650	7.85	16.88	92.0	46.5
Watertown, . . .	47.60	Separate, . . .	2,908	5.90	17,160	18,830	2.31	4.04	91.1	57.2
Waltham, . . .	47.36	Separate, . . .	3,902	7.70	30,050	32,060	2.44	13.63	93.7	17.9
Boston (Dorchester), .	58.21	Separate and combined,	5,981	11.80	70,580	88,010	2.55	4.89	80.2	52.1
Milton, . . .	17.55	Separate and combined,	962	5.00	4,810	9,350	0.97	12.59	51.4	7.7
Boston (Hyde Park), .	34.51	Separate, . . .	2,427	7.40	17,960	20,120	1.61	4.57	89.3	35.2
Dedham, . . .	17.40	Separate, . . .	881	5.50	4,850	12,100[2]	0.87	9.40	40.1	9.3
Boston (Roxbury),[3] .	-	- -	-	-	-	45,800	-	1.23	-	-
Boston (West Roxbury),	60.12	Separate and combined,	4,060	8.20	35,330[4]	46,290	2.70	8.92	76.3	30.3
Quincy, . . .	82.24	Separate, . . .	6,006	5.50	33,030	44,740	3.45	12.56	73.8	27.5
Wellesley,[5] . . .	-	- -	-	-	-	7,240	-	9.89	-	-
Totals, . . .	658.10	- -	45,598	8.20	372,980	491,200	32.75	110.76	75.9	29.6

[1] Estimated from assessors' statement of the number of houses in the city or town on April 1, 1918, and the population from census of 1915.
[2] Part of town not included in Metropolitan Sewerage District.
[3] At present connected with Boston Main Drainage System.
[4] Including connection with institutions at Austin Farm, having an estimated population of 2,020.
[5] Wellesley not yet connected with metropolitan sewer.

Both Metropolitan Sewerage Systems.

Table showing Areas delivering Sewage to both Systems; Approximate Miles of Sewers connected; Estimated Populations and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on Such Areas; Ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to Present Total Populations.

[Population estimated as of December 31, 1918.]

System.	Miles of Sewers connected.	Separate or Combined.	Number of Connections with Local Sewers.	Estimated Number of Persons served by Each House Connection.	Estimated Population now contributing Sewage.	Estimated Present Total Population.	Estimated Area now contributing Sewage.	Area ultimately to contribute Sewage.	Ratio of Contributing Population to Present Total Population.	Ratio of Contributing Area to Ultimate Area.
							Sq. Miles.	Sq. Miles.	Per Cent.	Per Cent.
North Metropolitan, .	774.30	Separate and combined,	84,773	6.8	579,440	646,270	32.58	100.32	89.7	32.5
South Metropolitan, .	658.10	Separate and combined,	45,598	8.2	372,980	491,200	32.75	110.76	75.9	29.6
Totals, . . .	1,432.40	- -	130,371	7.3	952,420	1,137,470	65.33	211.08	83.7	31.0

PUMPING STATIONS.

Capacities and Results.

The following table shows the comparison of the growth in the amount of sewage handled and the cost of the same at the different stations in 1918 with the same items of 1917 and of 1914 when prices had not been affected by the war: —

Pumping Station.	Sewage pumped in 1918 increased over that of —		Cost of Pumping in 1918 increased over that of —	
	1917.	1914.	1917.	1914.
	Per Cent.	Per Cent.	Per Cent.	Per Cent.
Deer Island,	3	13	17	48
East Boston,	3	14	33	48
Charlestown,	3	14	14	26
Alewife Brook,	11	7	11	37
Quincy,	4	6	20	44
Ward Street,	.2[1]	6	25	55

[1] Decrease.

Average Daily Volume of Sewage lifted at Each of the Six Principal Metropolitan Sewerage Pumping Stations and at the Quincy (Hough's Neck) Sewage Lifting Station during the Year, as compared with the Corresponding Volumes for the Previous Year.

Pumping Station.	Average Daily Pumpage.			
	Jan. 1, 1917, to Dec. 31, 1917.	Jan. 1, 1918, to Dec. 31, 1918.	Increase during the Year.	
	Gallons.	Gallons.	Gallons.	Per Cent.
Deer Island,	64,600,000	66,500,000	1,900,000	2.9
East Boston,	62,600,000	64,500,000	1,900,000	3.0
Charlestown,	36,300,000	37,300,000	1,000,000	2.7
Alewife Brook,	3,393,000	3,767,000	374,000	11.0
Quincy,	4,033,000	4,218,000	185,000	4.5
Ward Street (actual gallons pumped),	28,457,000	28,395,000	62,000[1]	0.2[1]
Quincy (Hough's Neck) sewage lifting station.	184,799	173,128	11,671[1]	6.3[1]

[1] Decrease.

North Metropolitan System.

Deer Island Pumping Station.

At this station are four submerged centrifugal pumps with impeller wheels 8.25 feet in diameter, driven by triple-expansion engines of the Reynolds-Corliss type.

Contract capacity of 1 pump: 100,000,000 gallons, with 19-foot lift.
Contract capacity of 3 pumps: 45,000,000 gallons each, with 19-foot lift.
Average duty for the year: 58,700,000 foot-pounds.
Average quantity raised each day: 66,500,000 gallons.
Force employed: 4 engineers, 1 relief engineer, 4 firemen, 4 oilers, 3 screenmen, 1 relief screenman and 1 laborer.
Coal used: Bituminous, costing from $9.60 to $11.80 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the Deer Island Pumping Station of the North Metropolitan System.

Months.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1918.						
January,	2,097,100,000	67,600,000	54,900,000	87,400,000	8.80	55,700,000
February,	2,273,400,000	81,200,000	60,400,000	120,800,000	7.76	48,400,000
March,	2,316,900,000	74,700,000	53,400,000	119,600,000	9.22	56,800,000
April,	2,110,400,000	70,300,000	51,400,000	119,400,000	9.32	56,600,000
May,	2,020,100,000	65,200,000	51,400,000	94,400,000	9.45	61,500,000
June,	1,812,600,000	60,400,000	50,600,000	95,000,000	9.90	60,700,000
July,	1,859,100,000	60,000,000	48,900,000	83,500,000	9.40	60,300,000
August,	1,790,100,000	57,700,000	47,600,000	77,400,000	9.99	61,800,000
September,	2,125,800,000	70,900,000	47,100,000	126,900,000	10.41	63,200,000
October,	1,770,000,000	57,100,000	41,400,000	79,500,000	10.58	54,400,000
November,	1,856,600,000	61,900,000	51,700,000	97,800,000	10.92	60,900,000
December,	2,197,600,000	70,900,000	51,100,000	112,500,000	11.35	64,200,000
Total,	24,229,700,000	-	-	-	-	-
Average,	-	66,500,000	50,800,000	101,200,000	9.76	58,700,000

Average Cost per Million Foot-gallons for Pumping at the Deer Island Station.

Volume (24,229.7 Million Gallons) × Lift (9.76 Feet) = 236,481.9 Million Foot-gallons.

Items.	Cost.	Cost per Million Foot-gallons.
Labor,	$19,157 33	$0.08101
Coal,	24,525 00	0.10371
Oil,	289 47	0.00122
Waste,	131 95	0.00056
Water,	1,344 00	0.00568
Packing,	102 33	0.00043
Miscellaneous supplies, repairs and renewals,	799 03	0.00338
Totals,	$46,349 11	$0.19599
Labor at screens,	$3,155 68	-

East Boston Pumping Station.

At this station are four submerged centrifugal pumps, with impeller wheels 8.25 feet in diameter, driven by triple-expansion engines of the Reynolds-Corliss type.

Contract capacity of 1 pump: 100,000,000 gallons, with 19-foot lift.
Contract capacity of 3 pumps: 45,000,000 gallons each, with 19-foot lift.
Average duty for the year: 68,200,000 foot-pounds.
Average quantity raised each day: 64,500,000 gallons.
Force employed: 4 engineers, 2 relief engineers, 3 firemen, 1 relief fireman, 4 oilers, 3 screenmen, 1 relief screenman, 3 helpers and 1 laborer.
Coal used: Bituminous, costing from $5.65 to $11.68 per gross ton, and anthracite screenings, costing $6.04 to $6.35 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the East Boston Pumping Station of the North Metropolitan System.

Months.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1918.						
January,	2,035,100,000	65,600,000	52,900,000	85,400,000	14.13	62,600,000
February,	2,217,400,000	79,200,000	58,400,000	118,800,000	14.07	62,700,000
March,	2,254,900,000	72,700,000	51,400,000	117,600,000	14.17	61,500,000
April,	2,050,400,000	68,300,000	49,400,000	117,400,000	14.23	74,900,000
May,	1,958,100,000	63,200,000	49,400,000	92,400,000	14.11	63,800,000
June,	1,752,600,000	58,400,000	48,600,000	93,000,000	13.98	62,900,000
July,	1,797,100,000	58,000,000	46,900,000	81,500,000	14.17	71,800,000
August,	1,728,100,000	55,700,000	45,600,000	75,400,000	13.60	77,500,000
September,	2,065,800,000	68,900,000	45,100,000	124,900,000	13.77	67,700,000
October,	1,708,000,000	55,100,000	39,400,000	77,500,000	14.16	61,000,000
November,	1,796,600,000	59,900,000	49,700,000	95,800,000	14.61	79,400,000
December,	2,135,600,000	68,900,000	49,100,000	110,500,000	14.71	72,000,000
Total,	23,499,700,000	-	-	-	-	-
Average,	-	64,500,000	48,800,000	99,200,000	14.14	68,200,000

Average Cost per Million Foot-gallons for Pumping at the East Boston Station.

Volume (23,499.7 Million Gallons) × Lift (14.14 feet) = 332,285.8 Million Foot-gallons.

Items.	Cost.	Cost per Million Foot-gallons.
Labor,	$23,013 39	$0.06926
Coal,	30,700 00	0.09239
Oil,	709 51	0.00213
Waste,	56 27	0.00017
Water,	1,831 66	0.00551
Packing,	195 68	0.00059
Miscellaneous supplies, repairs and renewals,	1,142 60	0.00344
Totals,	$57,649 11	$0.17349
Labor at screens,	$1,642 50	-

Charlestown Pumping Station.

At this station are three submerged centrifugal pumps, two of them having impeller wheels 7.5 feet in diameter, the other 8.25 feet in diameter. They are driven by triple-expansion engines of the Reynolds-Corliss type.

Contract capacity of 1 pump: 60,000,000 gallons, with 8-foot lift.
Contract capacity of 2 pumps: 22,000,000 gallons each, with 11-foot lift.
Average duty for the year: 46,400,000 foot-pounds.
Average quantity raised each day: 37,300,000 gallons.
Force employed: 4 engineers, 1 relief engineer, 4 firemen, 3 oilers, 3 screenmen and 1 relief screenman.
Coal used: Bituminous, costing from $9.30 to $12.43 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the Charlestown Pumping Station of the North Metropolitan System.

Months.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1918.						
January,	1,187,600,000	38,300,000	30,800,000	66,300,000	6.01	57,200,000
February,	1,164,000,000	41,600,000	31,100,000	69,100,000	5.75	58,700,000
March,	1,180,600,000	38,100,000	30,500,000	67,400,000	5.56	45,700,000
April,	1,225,500,000	40,800,000	28,400,000	65,200,000	6.08	51,700,000
May,	1,153,100,000	37,200,000	31,600,000	50,200,000	6.21	44,300,000
June,	1,037,100,000	34,600,000	26,700,000	53,800,000	5.92	38,200,000
July,	1,022,900,000	33,000,000	25,200,000	44,800,000	6.64	42,800,000
August,	1,006,000,000	32,500,000	24,200,000	47,700,000	5.96	35,500,000
September,	1,160,500,000	38,700,000	25,000,000	57,900,000	6.02	41,200,000
October,	1,020,500,000	34,000,000	27,700,000	46,900,000	6.70	43,800,000
November,	1,069,800,000	35,700,000	27,700,000	58,500,000	7.06	47,000,000
December,	1,332,400,000	43,000,000	25,600,000	66,400,000	8.13	50,700,000
Total,	13,560,000,000	-	-	-	-	-
Average,	-	37,300,000	27,900,000	57,900,000	6.34	46,400,000

Average Cost per Million Foot-gallons for Pumping at the Charlestown Station.

Volume (13,560.0 Million Gallons) × Lift (6.34 Feet) = 85,970.4 Million Foot-gallons.

Items.	Cost.	Cost per Million Foot-gallons.
Labor,	$16,026 61	$0.18642
Coal,	10,200 00	0.11865
Oil,	287 39	0.00334
Waste,	20 59	0.00024
Water,	655 17	0.00762
Packing,	21 21	0.00025
Miscellaneous supplies, repairs and renewals,	316 56	0.00368
Totals,	$27,527 53	$0.32020
Labor at screens,	$3,159 43	-

Alewife Brook Pumping Station.

The plant at this station consists of two 9-inch Andrews commercial centrifugal pumps, direct-connected by horizontal shafts to compound marine engines, together with a pump and engine added later. The latter consists of a specially designed engine of the vertical cross-compound type, having between the cylinders a centrifugal pump rotating on a horizontal axis.

Contract capacity of the 2 original pumps: 4,500,000 gallons each, with 13-foot lift.
Contract capacity of new pump: 13,000,000 gallons, with 13-foot lift.
Average duty for the year: 15,000,000 foot-pounds.
Average quantity raised each day: 3,767,000 gallons.
Force employed: 3 engineers, 1 relief engineer, 3 screenmen and 1 relief screenman.
Coal used: Bituminous, costing from $8.40 to $12.37 per gross ton, and anthracite screenings, costing $5.30 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the Alewife Brook Pumping Station of the North Metropolitan System.

Months.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1912.						
January,	91,835,000	2,962,000	2,456,000	5,559,000	13.10	10,600,000
February,	118,663,000	4,238,000	2,786,000	8,052,000	13.08	14,400,000
March,	163,763,000	5,283,000	4,201,000	8,229,000	13.04	17,900,000
April,	135,582,000	4,519,000	3,478,000	6,400,000	12.97	14,600,000
May,	117,208,000	3,781,000	3,028,000	6,076,000	13.07	16,600,000
June,	98,521,000	3,284,000	2,739,000	5,623,000	13.00	15,000,000
July,	94,434,000	3,046,000	2,550,000	3,862,000	13.01	14,000,000
August,	83,970,000	2,709,000	2,330,000	3,910,000	13.00	14,400,000
September,	118,464,000	3,949,000	2,372,000	7,167,000	12.97	16,400,000
October,	126,468,000	4,080,000	2,978,000	5,688,000	13.00	16,500,000
November,	91,374,000	3,046,000	2,598,000	5,106,000	13.00	13,700,000
December,	133,405,000	4,303,000	2,692,000	6,754,000	13.10	15,300,000
Total,	1,373,687,000	-	-	-	-	-
Average,	-	3,767,000	2,851,000	6,036,000	13.03	15,000,000

Average Cost per Million Foot-gallons for Pumping at the Alewife Brook Station.

Volume (1,373.687 Million Gallons) × Lift (13.03 Feet) = 17,899.14 Million Foot-gallons.

Items.	Cost.	Cost per Million Foot-gallons.
Labor,	$5,751 18	$0.32131
Coal,	5,760 00	0.32180
Oil,	212 01	0.01185
Waste,	90 08	0.00503
Water,	229 44	0.01282
Packing,	5 19	0.00029
Miscellaneous supplies, repairs and renewals,	101 63	0.00568
Totals,	$12,149 53	$0.67878
Labor at screens, oiling and miscellaneous services,	$3,428 04	-

South Metropolitan System.

Ward Street Pumping Station.

At this station are two vertical, triple-expansion pumping engines, of the Allis-Chalmers type, operating reciprocating pumps, the plungers of which are 48 inches in diameter with a 60-inch stroke.

Contract capacity of 2 pumps: 50,000,000 gallons each, with 45-foot lift.
Average duty for the year: 78,932,000 foot pounds.
Average quantity raised each day: 28,395,000 gallons.
Force employed: 4 engineers, 1 relief engineer, 4 firemen, 5 oilers, 4 assistant engineers, 1 machinist and 1 laborer.
Coal used: Bituminous, costing from $9.25 to $13.22 per gross ton, and anthracite screenings, costing $7.56 to $7.90 per gross ton.
Material intercepted at screens during the year: 1,474.7 cubic yards.

Table of Approximate Quantities, Lifts and Duties at the Ward Street Pumping Station of the South Metropolitan System.

Months.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1918.						
January,	817,551,000	26,373,000	23,612,000	36,343,000	39.79	69,646,000
February,	859,142,000	30,684,000	24,400,000	43,508,000	40.03	69,408,000
March,	1,048,941,000	33,837,000	25,761,000	54,459,000	40.73	74,100,000
April,	947,860,000	31,595,000	25,066,000	45,170,000	41.09	79,553,000
May,	971,901,000	31,351,000	24,764,000	41,861,000	41.31	90,248,000
June,	755,477,000	25,183,000	22,374,000	39,646,000	40.80	82,684,000
July,	770,294,000	24,848,000	21,133,000	30,753,000	40.38	76,890,000
August,	692,279,000	22,332,000	19,555,000	27,625,000	40.06	76,754,000
September,	896,278,000	29,876,000	19,666,000	49,751,000	40.46	88,680,000
October,	900,896,000	29,061,000	26,658,000	34,724,000	40.49	83,226,000
November,	777,512,000	25,917,000	22,985,000	34,948,000	40.28	72,900,000
December,	920,268,000	29,686,000	22,374,000	39,098,000	40.55	83,089,000
Total,	10,358,399,000	-	-	-	-	-
Average,	-	28,395,000	23,196,000	39,824,000	40.50	78,932,000

Records from plunger displacements.

Average Cost per Million Foot-gallons for Pumping at the Ward Street Station.

Volume (10,358.399 Million Gallons) × Lift (40.50) = 419,515.16 Million Foot-gallons.

Items.	Cost.	Cost per Million Foot-gallons.
Labor,	$18,185 86	$0.04335
Coal,	27,690 15	0.06601
Oil,	302 58	0.00072
Waste,	-	-
Water,	1,677 60	0.00400
Packing,	463 64	0.00111
Miscellaneous supplies, repairs and renewals,	3,373 71	0.00804
Totals,	$51,693 54	$0.12323
Labor at screens,	$4,827 16	-

Quincy Pumping Station.

At this station are two compound condensing Deane pumping engines and one Lawrence centrifugal pump driven by a Sturtevant compound condensing engine.

Contract capacity of 3 pumps: Deane, 3,000,000 gallons; Deane, 5,000,000 gallons; Lawrence centrifugal, 10,000,000 gallons.
Average duty for the year: 29,600,000 foot-pounds.
Average quantity raised each day: 4,218,000 gallons.
Force employed: 3 engineers, 1 relief engineer, 3 screenmen and 1 relief screenman.
Coal used: Bituminous, costing $7.92 to $13.22 per gross ton, and anthracite screenings, costing $6 per gross ton.
Materials intercepted at screen during the year: 309 cubic yards.

Table of Approximate Quantities, Lifts and Duties at the Quincy Pumping Station of the South Metropolitan System.

Months.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1918.						
January,	120,025,000	3,872,000	3,235,000	5,648,000	21.48	24,400,000
February,	125,477,000	4,481,000	3,334,000	9,899,000	23.26	28,500,000
March,	167,318,000	5,397,000	4,226,000	6,709,000	26.91	32,200,000
April,	174,080,000	5,803,000	4,216,000	12,598,000	24.18	30,800,000
May,	154,222,000	4,975,000	3,930,000	6,809,000	22.19	28,300,000
June,	110,003,000	3,667,000	3,234,000	4,100,000	21.03	27,800,000
July,	109,921,000	3,546,000	2,968,000	4,974,000	20.99	26,900,000
August,	98,139,000	3,166,000	2,843,000	3,619,000	20.84	31,300,000
September,	111,252,000	3,708,000	2,109,000	6,186,000	21.82	32,500,000
October,	126,084,000	4,067,000	3,623,000	4,808,000	21.79	31,100,000
November,	107,536,000	3,585,000	3,283,000	4,282,000	21.01	30,600,000
December,	134,931,000	4,353,000	3,360,000	5,280,000	22.77	31,200,000
Total,	1,538,988,000	-	-	-	-	-
Average,	-	4,218,000	3,363,000	6,243,000	22.36	29,600,000

Average Cost per Million Foot-gallons for Pumping at the Quincy Station.

Volume (1,538.988 Million Gallons) × Lift (22.36) = 34,411.77 Million Foot-gallons.

Items.	Cost.	Cost per Million Foot-gallons.
Labor,	$6,082 15	$0.17675
Coal,	5,667 48	0.16470
Oil,	61 40	0.00178
Waste,	19 29	0.00056
Water,	267 32	0.00777
Packing,	6 62	0.00019
Miscellaneous supplies, repairs and renewals,	271 69	0.00789
Totals,	$12,375 95	$0.35964
Labor at screens, oiling and miscellaneous services,	$3,543 06	-

Nut Island Screen-house.

The plant at this house includes two sets of screens in duplicate actuated by small reversing engines of the Fitchburg type. Two vertical Dean boilers, 80 horse power each, operate the engines, provide heat and light for the house, burn materials intercepted at the screens, and furnish power for the Quincy (Hough's Neck) sewage lifting station.

Average daily quantity of sewage passing screens: 56,200,000 gallons.
Total materials intercepted at screens: 709.9 cubic yards.
Materials intercepted per million gallons of sewage discharged: 0.93 cubic feet.
Force employed: 3 engineers, 1 relief engineer, 3 screenmen and 1 relief screenman.
Coal used: Bituminous, costing $10.55 per gross ton.

Quincy (Hough's Neck) Sewage Lifting Station.

At this station are two 6-inch submerged Lawrence centrifugal pumps with vertical shafts actuated by two Sturtevant direct-current motors.

The labor and electric energy for this station are supplied from the Nut Island screen-house and as used at present it does not materially increase the amount of coal used at the latter station. The effluent is largely ground water.

Contract capacity of 2 pumps: about 1,500,000 gallons each, with 20-foot lift.
Average daily amount pumped: 173,128 gallons.
Average lift: 15.31 feet.

Coal delivered in the Bins of the Sewerage Works Pumping Stations during the Year.

	Gross Tons, Bituminous Coal.							
	Deer Island Pumping Station.	East Boston Pumping Station.	Charlestown Pumping Station.	Alewife Brook Pumping Station.	Ward Street Pumping Station.	Quincy Pumping Station.	Nut Island Screen-house.	Price per Gross Ton.
C. H. Sprague & Son,	504	-	-	-	-	-	-	$11 80
Maritime Coaling Co.,	500	-	-	-	-	-	-	9 91
Maritime Coaling Co.,	500	-	-	-	-	-	-	10 25
Maritime Coaling Co.,	1,160	-	-	-	-	-	-	10 90
N. E. Coal & Coke Co.,	-	112	-	-	-	-	-	5 65
Staples Coal Co.,	-	31	-	-	-	-	-	7 11
Coastwise Coal Co.,	-	7	-	-	-	-	-	9 30
Maritime Coaling Co.,	-	326	-	-	-	-	-	10 07
Maritime Coaling Co.,	-	500	-	-	-	-	-	10 14
Maritime Coaling Co.,	-	378	-	-	-	-	-	10 55
Maritime Coaling Co.,	-	485	-	-	-	-	-	11 08
Maritime Coaling Co.,	-	513	-	-	-	-	-	11 48
Castner, Curran & Bullitt,	-	351	-	-	-	-	-	11 57
N. E. Coal & Coke Co.,	-	251	-	-	-	-	-	11 68
Coastwise Coal Co.,	-	-	15	-	-	-	-	9 30
Maritime Coaling Co.,	-	-	290	-	-	-	-	10 25
N. E. Coal & Coke Co.,	-	-	103	-	-	-	-	12 43
Maritime Coaling Co.,	-	-	263	-	-	-	-	11 46
Maritime Coaling Co.,	-	-	20	-	-	-	-	11 53
Castner, Curran & Bullitt,	-	-	217	-	-	-	-	11 56
Locke Coal Co.,	-	-	-	9	-	-	-	5 30
Gorman-Leonard Coal Co.,	-	-	-	48	-	-	-	8 40
Locke Coal Co.,	-	-	-	10	-	-	-	9 85
Locke Coal Co.,	-	-	-	394	-	-	-	11 50
Castner, Curran & Bullitt,	-	-	-	23	-	-	-	11 88
Locke Coal Co.,	-	-	-	50	-	-	-	12 37
Batchelder Bros.,	-	-	-	-	7	-	-	10 40
Staples Coal Co.,	-	-	-	-	1	-	-	7 05
Staples Coal Co.,	-	-	-	-	14	-	-	7 60
Staples Coal Co.,	-	-	-	-	7	-	-	9 25
Staples Coal Co.,	-	-	-	-	97	-	-	10 50
C. H. Sprague & Son,	-	-	-	-	198	-	-	10 62

Coal delivered in the Bins of the Sewerage Works Pumping Stations during the Year — Concluded.

	Gross Tons, Bituminous Coal.							
	Deer Island Pumping Station.	East Boston Pumping Station.	Charlestown Pumping Station.	Alewife Brook Pumping Station.	Ward Street Pumping Station.	Quincy Pumping Station.	Nut Island Screen-house.	Price per Gross Ton.
Batchelder Bros.,	-	-	-	-	13	-	-	$10 73
Staples Coal Co.,	-	-	-	-	183	-	-	11 25
Staples Coal Co.,	-	-	-	-	2,312	-	-	11 50
Staples Coal Co.,	-	-	-	-	97	-	-	13 22
E. Russell Norton,	-	-	-	-	-	41	-	7 92
E. Russell Norton,	-	-	-	-	-	28	-	7 97
E. Russell Norton,	-	-	-	-	-	42	-	8 34
E. Russell Norton,	-	-	-	-	-	246	-	8 45
E. Russell Norton,	-	-	-	-	-	47	-	8 55
City Fuel Co.,	-	-	-	-	-	47	-	11 50
Staples Coal Co.,	-	-	-	-	-	119	-	11 50
J. F. Sheppard & Sons, Inc.,	-	-	-	-	-	24	-	13 22
Maritime Coaling Co.,	-	-	-	-	-	-	400	10 55
Total, bituminous,	2,664	2,923	908	525	2,914	594	400	-
Total, screenings,	-	31	-	9	15	-	-	-
Average cost, bituminous,	$10 76	$10 74	$11 18	$11 31	$11 51	$9 54	$10 55	-
Average cost, screenings,	-	$7 11	-	$5 30	$7 74	-	-	-

Metropolitan Sewerage Outfalls.

The extension of the Deer Island outfall was fully described in last year's report. It has been in operation during the year and the condition of the harbor water at this point is very much improved. Except at the slack periods of the tide at high and low water it is difficult to detect the presence of sewage in this locality.

The 60-inch outfalls of the South Metropolitan System, two of which were completed in 1904 and the third one in 1915, are in good condition and free from deposit.

During the year the average flow through the North Metropolitan outfall at Deer Island has been 66,500,000 gallons of sewage per 24 hours, with a maximum rate of 163,000,000 gallons during a stormy

period in February, 1918. The amount of sewage discharged in the North Metropolitan District averaged 115 gallons per day for each person, taking the estimated population of the district contributing sewage. If the sewers in this district were restricted to the admission of sewage proper only, this per capita amount would be considerably decreased.

In the South Metropolitan District an average of 56,200,000 gallons of sewage has passed daily through the screens at the Nut Island screen-house, and has been discharged from the outfalls into the outer harbor. The maximum rate of discharge per day, which occurred during a heavy storm on June 12, 1918, was 152,500,000 gallons. The discharge of sewage through these outfalls represents the amount of sewage contributed in the South Metropolitan System, which was at the rate of 151 gallons per day per person of the estimated number contributing sewage in the district.

The daily discharge of sewage per capita is considerably larger in the South Metropolitan District than it is in the North Metropolitan District, because, owing to the large size and unused capacity of the High-level Sewer, more storm water is at present admitted to the sewers.

Material Intercepted at the Screens.

The material intercepted at the screens at the North Metropolitan Sewerage stations, consisting of rags, paper and other floating materials, has during the year amounted to 1,742.8 cubic yards. This is equivalent to 1.942 cubic feet for each million gallons of sewage pumped at Deer Island.

The material intercepted at the screens at the South Metropolitan Sewerage stations has amounted to 2,493.6 cubic yards, equal to 3.28 cubic feet per million gallons of sewage delivered at the outfall works at Nut Island.

Studies of sewage flows in the Metropolitan sewers and siphons indicate that they are free from deposit.

FREDERICK D. SMITH,
Chief Engineer of Sewerage Works.

BOSTON, January 1, 1919.

APPENDIX.

APPENDIX No. 1.

CONTRACTS MADE AND PENDING DURING

[NOTE. — The details of contracts made before

	1. Number of Contract.	2. WORK.	3. Number of Bids.	Amount of Bid. 4. Next to Lowest.	5. Lowest.	6. Contractor.
1	382[1]	Centrifugal pumping unit for Northern Extra High Service pumping station, Arlington.	3	$10,655 00	$9,000 00[2]	F. A. Mazzur & Co., Boston.
2	383[1]	Horizontal fire-tube boiler for Northern Extra High Service pumping station, Arlington.	3	2,369 00	2,296 00[2]	New England Iron Works Co., Boston.
3	385[1]	Electric power transmission line between Wachusett power station in Clinton and Sudbury power station in Southborough.	3	79,000 00	74,477 00[2]	Fred T. Ley & Co., Springfield, Mass.
4	386[1]	Furnishing steel work for extension of coal pocket at the Northern Extra High Service pumping station, Arlington.	3	672 00	620 00[2]	Builders Iron & Steel Co., Cambridge, Mass.
5	387[1]	Laying 20-inch water pipes in Boston and Newton.	8	30,465 00[2]	30,455 00	Michele De Sisto, West Roxbury, Mass.
6	388[1]	940 tons 20-inch cast-iron water pipe; 12 tons special castings.	2	52,080 00	51,772 50[2]	United States Cast Iron Pipe & Foundry Co., Philadelphia, Pa.
7	389[1]	36,300 pounds 12-inch flexible-jointed cast-iron water pipe; 1,572 pounds special castings.	1	-	2,196 68[2]	United States Cast Iron Pipe & Foundry Co., Philadelphia, Pa.
8	390[1]	Furnishing and laying granite and seam face masonry for extension of coal pocket at Northern Extra High Service pumping station, Arlington.	5	1,295 00	1,119 00[2]	F. C. Alexander, Boston.

[1] Contract completed.

APPENDIX No. 1.

THE YEAR 1918 — WATER WORKS.

1918 have been given in previous reports.]

7. Date of Contract.	8. Date of Completion of Contract.	9. Prices of Principal Items of Contracts.	10. Value of Work done Dec. 31, 1918.	
Mar. 31, 1917	June 6, 1918	See previous report,	$9,700 00	1
May 15, 1917	July 15, 1918	See previous report,	2,324 51	2
July 28, 1917	July 24, 1918	See previous report,	74,875 14	3
Jan. 29, 1918	May 4, 1918	For whole work, $620,	620 00	4
May 29, 1918	Nov. 1, 1918	For laying 20-inch cast-iron pipe, $2.75 per lin. ft.; for laying 6-inch and 16-inch cast-iron pipe for blow-offs and connections, $2 per lin. ft.; for rock excavation above regular grade of bottom of trench, $6.50 per cu. yd.; for rock excavation below regular grade of bottom of trench, $8 per cu. yd.; for earth excavation below regular grade of bottom of trench, $2 per cu. yd.; for chambers for 20-inch valves, $60 each, for 16-inch and smaller valves, $40 each; for concrete masonry, $10 per cu. yd.	31,330 21	5
May 1, 1918	Nov. 27, 1918	For pipes, $53.70 per ton of 2,000 pounds, for special castings, $106.60 and $126.60 per ton of 2,000 pounds, all f. o. b. foundry.	51,701 97	6
June 26, 1918	Dec. 4, 1918	For flexible jointed pipe, 6 cents per pound; for special castings, 9.5 cents per pound, all less $6.90 per ton of 2,000 pounds allowed for freight.	2,221 37	7
July 12, 1918	Oct. 1, 1918	For whole work, $1,119, [2]	1,119 00	8

[2] Contract based upon this bid.

CONTRACTS MADE AND PENDING DURING

	1. Number of Contract.	2. WORK.	3. Number of Bids.	AMOUNT OF BID. 4. Next to Lowest.	AMOUNT OF BID. 5. Lowest.	6. Contractor.
9	39-M	Sale and purchase of electric energy to be developed at Sudbury Dam in Southborough.	2	–[3]	–[3]	Edison Electric Illuminating Co. of Boston.
10	51-M	Sale and purchase of electric energy to be developed at Wachusett Dam in Clinton.	1	–	$5.30 per M kilowatt hours.	New England Power Co. and Edison Electric Illuminating Co. of Boston.
11	52-M[1]	2,000 tons anthracite screenings for Chestnut Hill pumping stations, 240 tons for Arlington pumping station.	Chestnut Hill stations, 2. Arlington station, 2.	$5.15 per ton, subject to change in freight rate. $6 per ton, subject to change in freight rate.	$4.20[2] per ton, subject to change in freight rate. $4.65[2] per ton, subject to change in freight rate.	Dexter & Carpenter, Inc., Boston.
12	53-M[1]	400 tons anthracite screenings for Spot Pond pumping station.	1	–	$5.30 per ton, subject to change in freight rate.	Locke Coal Co., Malden, Mass.
13	54-M[1]	4,000 tons bituminous coal for Chestnut Hill pumping stations, 400 tons for Arlington pumping station.	Chestnut Hill stations, 2. Arlington station, 1.	$8.35 per ton, subject to change in freight rate. –	$7.35[2] per ton, subject to change in freight rate. $7.80[2] per ton, subject to change in freight rate.	Shaftsbury Coal and Coke Co., Inc., New York, N. Y.
14	55-M[1]	800 tons bituminous coal for Spot Pond pumping station.	2	$11 per ton, delivered at station.	$8.70[2] per ton, subject to change in freight rate or in mining wage scale, f. o. b. cars, Melrose.	E. Russell Norton, Boston.
15	56-M[1]	Venturi meter tube, register and chart recorder.	–[5]	–[5]	–[5]	Builders Iron Foundry, Providence, R. I.
16	59-M[1]	Ash conveyor for Spot Pond pumping station.	2	1,250 00	609 00[2]	George J. Hagan Co., Boston.
17	61-M[1]	Furnishing two electrically operated head gate hoists.	1	–	800 00[2]	Union Gear and Machine Co., Boston.

[1] Contract completed.

[2] Contract based upon this bid.

THE YEAR 1918 — WATER WORKS — *Continued.*

7. Date of Contract.	8. Date of Completion of Contract.	9. Prices of Principal Items of Contracts.	10. Value of Work done Dec. 31, 1918.	
Dec. 21, 1914	Jan. 1, 1922	About 5,000,000 kilowatt hours of energy per year at $6.25 per thousand kilowatt hours,	$66,817 86	9
Jan. 13, 1917	Jan. 1, 1929	About 7,000,000 kilowatt hours of energy per year at $5.30 per thousand kilowatt hours,	–[4]	10
June 4, 1917	Feb. 4, 1918	See previous report,	9,930 70	11
June 6, 1917	Jan. 22, 1918	See previous report,	2,304 87	12
July 9, 1917	June 8, 1918	See previous report,	27,420 85	13
May 28, 1917	April 16, 1918	See previous report,	6,701 51	14
Sept. 26, 1917	Jan. 25, 1918	See previous report,	725 00	15
Oct. 19, 1917	June 20, 1918	See previous report,	609 00	16
Mar. 4, 1918	June 14, 1918	For whole work, $800,	800 00	17

[3] Contract based upon bid of $6.25 per thousand kilowatt hours for entire output. Other bid for portion of output.

[4] Delivery of energy to begin Jan. 1, 1919.

[5] Competitive bids were not received.

CONTRACTS MADE AND PENDING DURING

	1. Number of Contract.	2. WORK.	3. Number of Bids.	Amount of Bid. 4. Next to Lowest.	5. Lowest.	6. Contractor.
18	62-M	3,000 tons anthracite screenings.	-	-	-	Dexter & Carpenter, Inc., Boston.
19	63-M	6,000 tons bituminous coal, .	-	-	-	E. Russell Norton, Boston.
20	Agreement.[1]	Sale and purchase of electric energy to be developed at Wachusett Dam after expiration of Contract No. 22-M and until energy is delivered under Contract No. 51-M after completion of transmission line under Contract No. 385.	-[6]	-[6]	-[6]	New England Power Co., Boston.
21	Agreement.[1]	Furnishing head gates for Wachusett Aqueduct.	4	$299 00	$250 00[2]	A. T. Stearns Lumber Co., Boston.
22	Agreement.[1]	Heat insulation of steam pipes and boilers at northern extra high service pumping station.	2	328 00	279 00[2]	Nightingale & Childs Co., Boston.

[1] Contract completed.
[2] Contract based upon this bid.

THE YEAR 1918 — WATER WORKS — *Continued.*

7. Date of Contract.	8. Date of Completion of Contract.	9. Prices of Principal Items of Contracts.	10. Value of Work done Dec. 31, 1918.	
May 13, 1918	-	For anthracite screenings, $2.25 per ton of 2,240 pounds f. o. b. mine.	$4,594 45	18
May 17, 1918	-	For bituminous coal the United States Fuel Administration's prices and purchasing commission at time of shipment — Contractor to act as Agent for the Board.	12,723 22	19
Oct. 1, 1916	Dec. 31, 1918	See previous report, ...	88,948 54	20
Feb. 19, 1918	Mar. 22, 1918	For whole work, $250, ...	246 75	21
Aug. 24, 1918	Oct. 15, 1918	For whole work, $279, ...	279 00	22

[a] Agreement made with New England Power Company with which the Connecticut River Transmission Company, the contractor under Contract No. 22-M, was consolidated.

CONTRACTS MADE AND PENDING DURING THE YEAR 1918 — WATER WORKS — *Concluded.*

Summary of Contracts 1895 to 1918, inclusive. [1]

	Value of Work done Dec. 31, 1918.
Distribution Department, 7 contracts,	$99,017 06
Wachusett Department, 1 contract,	74,875 14
388 contracts completed from 1896 to 1917, inclusive,	17,399,274 51
	$17,573,166 71
Deduct for work done on 11 Sudbury Reservoir contracts by the city of Boston,	512,000 00
Total of 396 contracts,	$17,061,166 71

[1] In this summary contracts charged to maintenance are excluded.

APPENDIX No. 2.

TABLE No. 1. — *Monthly Rainfall in Inches at Various Places on the Metropolitan Water Works, in 1918.*

	Place.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
Wachusett Watershed.	Princeton,	2.42	3.27	1.66	3.33	1.16	4.33	2.29	2.75	6.39	1.46	2.82	3.54	35.42
	Jefferson,	3.25	5.27	3.07	3.58	0.86	4.73	2.67	3.05	6.61	2.05	3.47	4.08	42.69
	Sterling,	2.67	4.51	1.97	3.15	1.17	3.96	2.13	3.02	6.94	1.26	3.25	3.86	37.89
	Boylston,	3.52	3.97	2.26	3.82	1.07	5.25	4.12	2.45	8.80	1.55	2.80	3.47	43.08
Sudbury Watershed.	Sudbury Dam,	3.49	3.50	2.38	4.10	1.06	3.64	3.82	1.73	8.07	0.97	2.80	3.46	39.02
	Framingham,	3.34	3.72	2.43	4.53	1.03	3.57	4.06	1.44	8.29	1.04	2.59	3.73	39.77
	Ashland Dam,	3.30	3.35	2.54	4.34	1.28	3.26	4.28	1.55	8.70	1.04	2.40	3.66	39.70
	Cordaville,	3.76	3.76	2.63	4.74	1.25	4.13	4.13	1.71	9.36	1.12	3.19	3.87	43.65
Lake Cochituate,		3.26	3.80	2.26	4.61	1.10	3.34	3.64	1.41	8.58	0.92	2.57	3.55	39.04
Chestnut Hill Reservoir,		3.46	4.04	1.98	4.50	1.17	2.40	3.93	1.68	9.34	1.25	1.88	4.18	39.81
Spot Pond,		3.56	3.51	2.46	4.31	1.37	2.67	3.63	2.18	9.42	1.13	2.05	4.07	40.36
Average of all,		3.26	3.88	2.33	4.09	1.14	3.75	3.52	2.09	8.23	1.25	2.71	3.77	40.02
Average, Wachusett watershed,		2.97	4.25	2.24	3.47	1.07	4.57	2.80	2.82	7.18	1.58	3.08	3.74	39.77
Average, Sudbury watershed,		3.47	3.58	2.50	4.43	1.16	3.65	4.07	1.61	8.60	1.04	2.75	3.68	40.54

TABLE NO. 2.—*Rainfall in Inches at Jefferson, Mass., in 1918.*

DAY OF MONTH.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1,	-	-	0.06	-	-	-	0.23	-	-	-	-	-
2,	-	-	-	-	-	-	-	-	-	-	-	-
3,	-	0.07[1]	-	0.12	-	-	-	-	-	0.63	-	-
4,	-	-	0.36[1]	-	-	-	0.12	0.15	-	-	[2]	-
5,	-	-	-	-	-	-	-	-	-	-	0.28	-
6,	[2]	0.50[1]	0.20	-	-	0.28	-	-	-	0.64	-	0.60[1]
7,	0.42[3]	-	0.68[1]	-	-	0.76	0.06	-	-	0.12	-	-
8,	-	-	-	-	-	-	-	-	0.52	-	-	0.07
9,	-	0.65[3]	[2]	0.08	-	-	-	0.78	-	-	[2]	-
10,	-	0.04[1]	1.38[3]	-	-	0.09	-	-	-	-	0.60	-
11,	-	-	-	[2]	-	-	0.09	0.27	-	-	-	[2]
12,	1.21[3]	-	0.08[3]	[2]	-	0.78	0.10	-	[2]	-	-	0.78[3]
13,	-	-	-	1,12[3]	-	-	-	-	1.12	-	-	[2]
14,	-	-	0.31[3]	-	0.26	0.41	0.19	0.98	-	-	-	[2]
15,	1.11[3]	0.31	-	-	-	-	-	-	-	-	-	0.99
16,	-	-	-	-	-	-	-	-	-	-	-	-
17,	-	0.06[1]	-	-	-	-	0.72	-	0.36	-	[2]	-
18,	-	-	-	0.22[3]	-	-	-	-	0.67	-	2.09	-
19,	0.23[1]	[2]	-	-	-	-	-	-	-	-	0.07	-
20,	-	1.51	-	-	-	-	-	-	[2]	[2]	-	-
21,	-	-	-	0.98	0.09	[2]	-	-	1.66	0.34	-	-
22,	0.12[1]	0.19[1]	-	-	-	2.28	-	-	-	-	-	0.42
23,	-	-	-	0.14	-	0.13	-	-	-	-	-	-
24,	-	-	-	-	-	-	-	-	0.08	-	-	[2]
25,	0.07[1]	[2]	-	-	0.24	7	-	-	-	-	-	0.65
26,	-	0.78	-	-	-	-	-	0.08	2.20	-	-	[2]
27,	-	-	-	-	-	-	-	-	-	-	-	0.09[1]
28,	[2]	1.16[3]	-	-	-	-	-	-	-	-	0.31	-
29,	0.09[1]	-	-	0.06	[2]	-	-	0.37	-	-	-	-
30,	-	-	-	[2]	0.27	-	[2]	-	-	[2]	[2]	-
31,	-	-	-	0.86	-	-	1.16	0.42	-	0.32	0.12	0.48[3]
Totals,	3.25	5.27	3.07	3.58	0.86	4.73	2.67	3.05	6.61	2.05	3.47	4.08

Total for the year, 42.69 inches.

[1] Snow. [2] Rainfall included in that of following day. [3] Rain and snow.

TABLE NO. 3.—*Rainfall in Inches at Framingham, Mass., in 1918.*

DAY OF MONTH.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1,	-	-	0.13[1]	-	0.08	-	[2]	-	-	-	-	-
2,	-	-	-	-	-	-	0.04	-	-	[2]	-	[2]
3,	0.02[1]	0.15[1]	-	0.20	-	-	-	-	-	0.09	-	[2]
4,	-	-	[2]	-	-	-	0.03	-	-	-	[2]	0.13[3]
5,	-	-	0.19[1]	-	-	-	[2]	0.16	-	-	0.35	-
6,	-	[2]	0.11	-	-	0.07	0.13	-	-	0.13	-	0.63[1]
7,	[2]	0.03[1]	0.45[1]	-	0.08	0.50	1.06	0.06	-	-	-	-
8,	0.74[3]	-	-	-	0.06	-	-	-	[2]	-	-	-
9,	-	0.28[3]	[2]	0.03	-	-	-	0.44	0.82	-	[2]	-
10,	-	0.04[1]	1.17[3]	-	-	0.05	0.38	-	-	-	0.16	-
11,	-	-	-	-	-	-	0.24	0.16	-	-	-	[2]
12,	1.13[3]	-	0.03	[2]	-	0.24	-	-	[2]	0.11	-	0.95[3]
13,	-	-	-	[2]	[2]	-	-	-	1.79	0.03	0.07	[2]
14,	[2]	-	0.35[3]	1.41[3]	0.29	0.02	-	0.26	-	-	-	[2]
15,	0.99[3]	0.08	-	-	-	-	-	-	-	-	-	0.67
16,	-	[2]	-	-	-	-	-	-	-	0.01	-	-
17,	-	0.14[1]	-	[2]	-	-	0.75	-	-	-	[2]	-
18,	-	-	-	0.28	-	-	-	-	1.16	-	1.64	-
19,	0.09[1]	[2]	-	-	-	0.07	-	-	-	-	-	-
20,	-	0.71	-	[2]	-	-	0.06	-	[2]	[2]	0.07	-
21,	-	-	-	1.28	[2]	[2]	-	-	1.60	0.17	-	-
22,	0.16[1]	0.15[1]	-	-	0.14	2.43	-	-	-	-	-	0.29
23,	-	-	-	0.07	-	0.19	-	-	-	-	-	-
24,	-	-	-	-	-	-	-	0.01	0.07	-	-	[2]
25,	0.02[1]	[2]	-	-	0.17	-	0.02	-	-	-	-	0.70
26,	-	1.04	-	-	-	-	-	0.03	[2]	0.02	-	-
27,	-	-	-	-	0.05	-	-	-	2.73	-	-	-
28,	[2]	1.10[3]	-	-	-	-	-	-	-	-	[2]	-
29,	0.19[1]	-	-	[2]	-	-	-	0.13	-	-	0.27	0.01[1]
30,	-	-	-	1.26	0.16	-	[2]	-	0.12	-	0.03[1]	-
31,	-	-	-	-	-	-	1.35	0.19	-	0.48	-	0.35[3]
Totals,	3.34	3.72	2.43	4.53	1.03	3.57	4.06	1.44	8.29	1.04	2.59	3.73

Total for the year, 39.77 inches.

[1] Snow. [2] Rainfall included in that of following day. [3] Rain and snow.

TABLE No. 4. — *Rainfall in Inches at Chestnut Hill Reservoir, 1918.*

Date.	Amount.	Duration.
Jan. 7,	.76[2]	5.00 A.M. to
Jan. 8,		7.30 A.M.
Jan. 12,	.66[2]	1.15 A.M. to 4.45 A.M.
Jan. 12,	.25	4.45 A.M. to 9.45 A.M.
Jan. 15,	.55[1]	1.15 A.M. to 9.45 A.M.
Jan. 15,	.44	9.45 A.M. to 12.45 P.M.
Jan. 17,	.04[1]	4.15 A.M. to 6.40 A.M.
Jan. 19,	.13[1]	1.15 A.M. to 9.30 A.M.
Jan. 19,	.05[1]	12.10 P.M. to 2.35 P.M.
Jan. 22,	.20[1]	12.00 M. to 7.00 P.M.
Jan. 25,	.05[1]	4.15 A.M. to 12.15 P.M.
Jan. 28,	.34	11.30 A.M. to
Jan. 29,		7.00 A.M.
Total,	3.46	
Feb. 3,	.16[1]	10.00 A.M. to 10.30 P.M.
Feb. 6,	.04[1]	6.20 P.M. to 11.00 P.M.
Feb. 9,	.36[1]	9.00 A.M. to 3.30 P.M.
Feb. 10,	.08[1]	9.00 A.M. to 7.00 P.M.
Feb. 15,	.15	12.30 A.M. to 8.45 A.M.
Feb. 16,	.16[1]	10.10 P.M. to
Feb. 17,		9.00 A.M.
Feb. 19,	.62	2.45 P.M. to
Feb. 20,		7.30 A.M.
Feb. 22,	.16[1]	3.00 P.M. to
Feb. 23,		2.00 A.M.
Feb. 26,	1.09	12.15 A.M. to 9.45 A.M.
Feb. 28,	1.22	11.00 A.M. to
Mar. 1,		7.30 A.M.
Total,	4.04	
Mar. 1,	.10	7.30 A.M. to 3.30 P.M.
Mar. 4,	.33[1]	8.00 P.M. to
Mar. 5,		3.00 A.M.
Mar. 6,	.10	6.00 A.M. to 9.00 A.M.
Mar. 7,	.40[1]	12.45 A.M. to 3.15 P.M.
Mar. 9,	.64[2]	7.30 P.M. to
Mar. 10,		12.30 A.M.
Mar. 10,	.11[1]	5.30 A.M. to 8.00 P.M.
Mar. 14,	.06[1]	4.30 A.M. to 12.00 M.
Mar. 14,	.21	12.00 M. to 9.00 P.M.
Total,	1.98	
Apr. 3,	.23	1.00 P.M. to
Apr. 4,		1.30 A.M.
Apr. 11,	.83[2]	11.30 P.M. to
Apr. 13,		8.00 A.M.
Apr. 13,	.29	8.00 A.M. to
Apr. 14,		3.30 A.M.
Apr. 17,	.33	9.35 P.M. to
Apr. 18,		4.30 A.M.
Apr. 20,	1.55	6.30 P.M. to
Apr. 21,		11.45 P.M.
Apr. 23,	.08	11.15 P.M. to
Apr. 24,		5.00 A.M.
Apr. 29,	.04	4.10 P.M. to
Apr. 30,		7.30 A.M.
May 1,	1.15	1.30 A.M. to 7.30 A.M.
Total,	4.50	
May 1,	.04	7.30 A.M. to 9.00 A.M.
May 6,	.04	4.00 P.M. to 4.30 P.M.
May 7,	.05	1.15 A.M. to 2.00 A.M.
May 8,	.06	10.00 A.M. to 10.30 A.M.
May 14,	.19	6.30 A.M. to 3.00 P.M.
May 22,	.20	12.15 A.M. to 6.45 A.M.
May 25,	.17	8.05 P.M. to
May 26,		2.15 A.M.
May 27,	.15	7.00 A.M. to 9.00 A.M.
May 28,	.17	3.45 P.M. to 7.30 P.M.
May 29,	.10	6.10 P.M. to
May 30,		3.00 A.M.
Total,	1.17	
June 6,	.05	3.15 P.M. to 6.30 P.M.
June 7,	.33	9.00 A.M. to 3.00 P.M.
June 9,	.08	5.15 A.M. to
June 10,		10.00 A.M.
June 12,	.16	7.30 A.M. to 9.00 P.M.
June 14,	.04	4.15 P.M. to 9.00 P.M.
June 19,	.03	8.40 P.M. to 10.45 P.M.
June 21,	1.67	11.00 P.M. to
June 22,		3.05 P.M.
June 23,	.04	9.10 A.M. to 8.30 P.M.
Total,	2.40	
July 1,	.25	6.50 P.M. to
July 2,		4.00 A.M.
July 4,	.03	12.00 M. to 5.40 P.M.
July 5,	.19	10.30 A.M. to
July 6,		1.15 P.M.
July 7,	.08	3.00 P.M. to 4.10 P.M.
July 10,	.05	1.15 A.M. to 3.30 A.M.
July 10,	.10	4.15 P.M. to 5.30 P.M.
July 11,	.25	10.20 P.M. to
July 12,		2.15 A.M.
July 12,	.63	4.15 P.M. to 5.30 P.M.
July 14,	.78	2.00 P.M. to 5.00 P.M.
July 15,	.05	8.05 P.M. to 8.50 P.M.
July 17,	.24	4.30 P.M. to
July 18,		8.30 P.M.
July 19,	.06	6.20 P.M. to 7.05 P.M.
July 30,	1.22	1.20 P.M. to
July 31,		11.15 A.M.
Total,	3.93	
Aug. 5,	.10	4.20 A.M. to 6.30 A.M.
Aug. 8,	.86	4.15 P.M. to
Aug. 11,		8.00 A.M.
Aug. 14,	.14	6.30 P.M. to 9.15 P.M.
Aug. 24,	.08	7.30 A.M. to 10.40 P.M.
Aug. 29,	.20	11.30 A.M. to 6.30 P.M.
Aug. 31,	.30	3.20 A.M. to 5.30 A.M.
Total,	1.68	

[1] Snow. [2] Rain and snow.

TABLE No. 4. — *Rainfall in Inches at Chestnut Hill Reservoir, 1918* — Concluded.

Date.	Amount.	Duration.
Sept. 8,	1.04	2.40 P.M. to
Sept. 9,		5.30 A.M.
Sept. 12,	2.40	6.00 P.M. to
Sept. 13,		2.15 P.M.
Sept. 17,	1.74	5.30 P.M. to
Sept. 18,		7.00 P.M.
Sept. 20,	1.44	6.20 A.M. to
Sept. 21,		9.15 A.M.
Sept. 24,	.12	5.00 A.M. to 3.00 P.M.
Sept. 25,	2.44	10.00 P.M. to
Sept. 27,		4.45 A.M.
Sept. 30,	.16	11.10 P.M. to
Oct. 1,		3.45 A.M.
Total,	9.34	
Oct. 2,	.08	10.20 P.M. to
Oct. 3,		8.00 A.M.
Oct. 6,	.20	4.25 P.M. to 5.00 P.M.
Oct. 12,	.15	2.15 P.M. to 8.00 P.M.
Oct. 16,	.04	5.15 A.M. to 7.30 A.M.
Oct. 20,	.16	7.10 P.M. to
Oct. 21,		6.30 A.M.
Oct. 26,	.04	10.00 P.M. to
Oct. 27,		2.00 A.M.
Oct. 30,	.58	11.30 P.M. to
Oct. 31,		3.30 P.M.
Total,	1.25	
Nov. 4,	.10	8.00 A.M. to
Nov. 5,		7.00 A.M.
Nov. 10,	.10	12.20 A.M. to 10.15 A.M.
Nov. 13,	.12	7.00 P.M. to 11.45 P.M.
Nov. 17,	1.30	10.15 A.M. to
Nov. 18,		11.15 P.M.
Nov. 20,	.08	4.30 A.M. to 6.20 P.M.
Nov. 28,	.18	9.00 P.M. to
Nov. 29,		7.30 A.M.
Total,	1.88	
Dec. 3,	.05[1]	12.30 A.M. to 6.00 A.M.
Dec. 4,	.21	2.30 A.M. to 9.30 P.M.
Dec. 6,	.60[1]	2.00 A.M. to 1.30 P.M.
Dec. 8,	.04	1.40 P.M. to 3.00 P.M.
Dec. 11,	1.09[2]	2.30 P.M. to
Dec. 12,		9.00 A.M.
Dec. 13,	.81	1.45 P.M. to
Dec. 15,		6.00 P.M.
Dec. 22,	.28	4.00 P.M. to
Dec. 23,		5.00 A.M.
Dec. 24,	.61	4.20 P.M. to
Dec. 25,		1.15 A.M.
Dec. 26,	.04[1]	2.00 P.M. to 6.30 P.M.
Dec. 28,	.05[1]	9.15 P.M. to
Dec. 29,		8.30 A.M.
Dec. 31,	.40	11.30 A.M. to
Jan. 1,		7.30 A.M.
Total,	4.18	

[1] Snow.

[2] Rain and snow.

TABLE No. 5. — *Rainfall in Inches on the Wachusett Watershed,*[1] *1897 to 1918.*

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
1897,	3.46	2.86	4.01	2.32	5.06	5.11	3.65	3.47	1.93	0.94	7.62	6.41	51.84
1898,	6.65	3.30	2.27	4.43	3.38	3.11	3.01	10.61	3.15	7.21	6.81	3.99	57.92
1899,	2.93	5.12	6.75	1.94	1.33	5.51	3.82	3.20	4.11	2.72	1.94	2.03	41.40
1900,	4.56	3.69	6.19	2.76	4.34	3.59	3.20	3.18	3.46	2.90	6.44	3.15	52.46
1901,	1.75	1.13	5.82	9.64	7.02	1.51	5.66	4.58	3.10	3.70	2.43	9.36	55.70
1902,	2.72	4.91	5.27	4.36	2.24	2.51	3.87	3.95	4.26	6.36	0.93	7.20	48.58
1903,	2.85	4.42	6.58	3.10	1.24	10.37	3.43	3.88	2.93	4.43	2.36	3.99	49.58
1904,	4.02	2.66	3.40	7.45	2.99	3.44	3.84	3.68	5.30	1.78	1.62	2.88	43.06
1905,	6.10	1.72	3.95	2.60	0.83	4.88	5.39	3.09	6.90	1.81	2.52	3.79	43.58
1906,	2.59	2.74	5.17	3.12	6.58	5.95	5.52	4.34	2.61	3.95	2.25	4.26	49.08
1907,	2.84	2.32	1.82	2.65	2.96	3.54	3.03	1.26	9.50	5.68	5.74	4.40	45.74
1908,	3.40	4.82	2.77	2.62	5.34	1.29	3.85	6.49	1.04	2.13	1.05	3.03	37.83
1909,	3.52	6.10	4.38	5.71	2.65	3.03	4.25	3.59	3.90	1.70	1.68	3.99	44.50
1910,	5.86	5.24	1.09	3.01	2.13	4.36	1.52	3.87	2.86	1.40	4.17	2.34	37.85
1911,	2.91	2.43	3.79	2.22	1.59	2.37	2.53	5.46	3.04	5.24	4.14	3.01	38.73
1912,	2.57	2.42	5.69	4.06	5.76	0.48	2.65	2.89	2.17	2.53	4.02	4.95	40.19
1913,	3.38	2.55	5.58	3.90	3.71	0.90	2.37	3.05	4.44	6.02	2.59	2.73	41.22
1914,	3.40	3.58	4.33	4.91	3.01	2.00	3.92	4.50	0.15	1.88	2.97	3.89	38.54
1915,	6.31	3.32	0.06	1.80	1.67	3.18	8.60	6.90	1.53	3.05	3.12	5.11	44.65
1916,	1.60	5.98	3.32	3.65	3.34	6.57	5.66	1.72	4.21	1.42	3.15	2.81	43.43
1917,	3.37	3.05	4.21	1.80	3.89	4.47	1.22	4.46	1.20	6.03	1.25	2.31	37.26
1918,	2.97	4.25	2.24	3.47	1.07	4.57	2.80	2.82	7.18	1.58	3.06	3.74	39.77
Totals,	79.76	83.61	88.69	81.52	72.13	82.74	88.79	90.99	78.97	74.46	71.88	89.37	982.91
Average (22 years),	3.62	3.80	4.03	3.71	3.28	3.76	4.04	4.14	3.59	3.38	3.27	4.06	44.68

[1] Means of observations at four places, as follows: January, 1897, to December, 1900, Princeton, Jefferson, Sterling and South Clinton; January, 1901, to December, 1916, Princeton, Jefferson, Sterling and Boylston.

TABLE NO. 6. — *Rainfall in Inches on the Sudbury Watershed,*[1] *1875 to 1918.*

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
1875,	2.42	3.15	3.74	3.23	3.56	6.24	3.57	5.53	3.43	4.85	4.83	0.94	45.49
1876,	1.83	4.21	7.43	4.20	2.76	2.04	9.13	1.72	4.62	2.24	5.76	3.62	49.56
1877,	3.22	0.74	8.36	3.43	3.70	2.43	2.95	3.68	0.32	8.52	5.80	0.87	44.02
1878,	5.63	5.97	4.69	5.79	0.96	3.88	2.97	6.94	1.29	6.42	7.02	6.37	57.93
1879,	2.48	3.56	5.14	4.72	1.58	3.79	3.93	6.51	1.88	0.81	2.68	4.34	41.42
1880,	3.57	3.98	3.31	3.11	1.84	2.14	6.27	4.01	1.60	3.74	1.78	2.83	38.18
1881,	5.56	4.65	5.73	2.00	3.51	5.39	2.35	1.36	2.62	2.95	4.09	3.96	44.17
1882,	5.95	4.55	2.65	1.82	5.07	1.66	1.77	1.67	8.74	2.07	1.15	2.30	39.40
1883,	2.81	3.87	1.78	1.84	4.19	2.40	2.68	0.73	1.52	5.60	1.81	3.55	32.78
1884,	5.09	6.54	4.72	4.41	3.47	3.44	3.67	4.65	0.85	2.48	2.65	5.17	47.14
1885,	4.71	3.87	1.07	3.60	3.48	2.87	1.43	7.18	1.43	5.09	6.09	2.72	43.54
1886,	6.36	6.28	3.61	2.22	3.00	1.47	3.27	4.10	2.90	3.24	4.64	4.97	46.06
1887,	5.20	4.78	4.90	4.27	1.16	2.65	3.76	5.28	1.32	2.83	2.67	3.88	42.70
1888,	4.15	3.68	6.02	2.43	4.82	2.54	1.41	6.22	8.59	4.99	7.22	5.40	57.47
1889,	5.37	1.65	2.37	3.41	2.95	2.90	8.94	4.18	4.60	4.25	6.29	3.14	49.95
1890,	2.53	3.51	7.73	2.64	5.21	2.03	2.46	3.87	6.00	10.51	1.20	5.31	53.00
1891,	7.02	5.23	6.48	3.91	2.01	3.77	3.39	4.73	2.38	3.83	3.09	3.68	49.52
1892,	5.85	3.14	4.06	0.83	5.58	2.76	4.23	4.44	2.84	1.17	5.80	1.13	41.83
1893,	2.92	8.20	3.67	3.60	6.61	2.38	2.57	5.41	1.74	4.07	2.20	4.86	48.23
1894,	4.09	3.91	1.43	3.42	4.24	1.15	3.26	2.03	2.63	5.34	3.43	4.81	39.74
1895,	4.06	1.39	2.98	5.25	2.02	2.77	5.04	4.15	2.30	10.68	6.63	3.35	50.62
1896,	2.39	7.18	5.24	1.57	2.57	3.22	2.51	2.40	7.72	3.76	3.02	2.12	43.70
1897,	4.00	2.91	3.66	2.82	4.37	4.46	5.44	3.51	2.94	0.47	6.40	5.21	46.19
1898,	6.83	4.49	2.40	4.66	3.22	2.48	4.09	8.17	2.62	6.71	6.93	3.28	55.88
1899,	4.18	4.91	7.01	1.90	1.45	2.51	3.22	1.43	3.95	2.69	2.18	1.78	37.21
1900,	4.96	9.14	6.35	2.58	4.32	2.99	2.42	2.26	3.36	3.83	5.70	2.74	50.65

[1] See note at end of this table.

TABLE No. 6. — *Rainfall in Inches on the Sudbury Watershed,*[1] *1875 to 1918* — Concluded.

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
1901,	1.82	1.52	6.57	8.60	7.23	1.38	5.71	4.57	3.30	2.82	2.90	9.69	56.11
1902,	2.52	6.18	5.34	4.13	1.86	2.89	2.94	3.40	4.54	4.44	1.45	6.38	46.07
1903,	3.80	3.95	6.63	2.99	0.93	9.25	2.77	3.67	1.75	4.72	1.56	3.14	45.16
1904,	4.87	3.00	2.72	8.87	2.65	2.80	1.96	3.86	5.80	1.64	1.73	2.92	42.82
1905,	5.26	2.20	3.15	2.72	1.31	5.00	5.47	2.70	6.88	1.54	2.07	4.01	42.31
1906,	2.47	2.92	6.32	2.88	5.66	3.91	3.42	3.02	3.30	3.40	2.69	4.49	44.48
1907,	3.28	2.17	1.91	3.41	3.63	3.53	1.86	1.07	8.76	4.17	6.12	4.47	44.38
1908,	3.60	4.56	3.82	1.88	5.51	0.86	3.71	4.57	0.97	2.55	0.98	3.14	36.15
1909,	3.98	5.79	4.26	4.67	2.43	2.81	1.59	2.93	4.74	1.12	3.38	4.05	41.75
1910,	5.39	5.06	0.85	2.75	1.29	4.68	2.03	2.62	2.49	1.86	4.13	2.49	35.64
1911,	2.88	2.77	3.59	2.81	1.01	2.53	3.19	4.94	2.75	3.69	4.62	3.60	38.38
1912,	2.94	2.77	6.46	4.37	4.55	0.46	3.24	3.05	1.76	2.35	3.64	5.13	40.72
1913,	3.17	2.82	5.75	4.25	3.97	1.98	3.60	3.64	3.77	5.53	2.65	3.18	44.31
1914,	3.85	4.07	4.57	5.10	3.08	1.90	3.44	3.82	0.29	1.60	2.53	3.46	37.71
1915,	6.51	3.58	0.05	2.48	1.74	3.65	8.12	5.87	1.10	2.95	2.79	5.09	43.93
1916,	1.53	5.91	4.16	4.19	3.43	4.77	5.17	2.01	1.80	1.49	2.28	3.22	39.96
1917,	3.50	2.68	4.96	2.41	4.93	4.23	1.11	6.40	1.52	5.65	1.31	2.81	41.51
1918,	3.47	3.58	2.50	4.43	1.16	3.65	4.07	1.61	8.60	1.04	2.75	3.68	40.54
Totals,	178.02	181.02	190.14	156.60	144.02	136.54	160.13	169.91	148.31	165.70	160.64	167.28	1,958.31
Average (44 years),	4.05	4.12	4.32	3.56	3.27	3.10	3.64	3.86	3.37	3.77	3.65	3.80	44.51

[1] Means of observations at several places, as follows: January, 1875, to March, 1876, inclusive, Lake Cochituate; April and May, 1876, Lake Cochituate, Westborough and Hopkinton; June to November, 1876, inclusive, Lake Cochituate, Southborough, Marlborough, Westborough and Hopkinton; December, 1876, to December, 1882, inclusive, Framingham, Southborough, Marlborough, Westborough and Hopkinton; January, 1883, to December, 1889, inclusive, Framingham and Westborough; January, 1890, to May, 1898, inclusive, Framingham and Ashland Dam; June, 1898, to December, 1916, inclusive, Framingham, Ashland Dam, Cordaville and Sudbury Dam.

TABLE NO. 7. — *Yield of the Wachusett Watershed in Gallons per Day per Square Mile*[1] *from 1897 to 1918.*

MONTH.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.
January,	796,000	1,563,000	2,092,000	796,000	519,000	1,676,000	1,265,000	659,000	1,266,000	1,132,000	1,458,000
February,	931,000	1,635,000	1,090,000	4,054,000	356,000	1,401,000	2,133,000	927,000	452,000	1,027,000	692,000
March,	2,760,000	3,088,000	2,776,000	3,722,000	2,718,000	3,992,000	3,423,000	3,008,000	3,004,000	1,860,000	1,697,000
April,	1,632,000	2,027,000	3,376,000	1,580,000	4,986,000	2,159,000	2,238,000	2,984,000	1,617,000	2,109,000	1,436,000
May,	1,163,000	1,390,000	862,000	1,382,000	2,729,000	1,031,000	569,000	1,498,000	445,000	1,533,000	965,000
June,	1,181,000	828,000	561,000	578,000	985,000	410,000	2,131,000	762,000	542,000	1,184,000	773,000
July,	1,442,000	333,000	354,000	217,000	477,000	292,000	624,000	497,000	365,000	728,000	335,000
August,	896,000	1,325,000	236,000	197,000	512,000	297,000	474,000	355,000	321,000	591,000	87,000
September,	380,000	676,000	250,000	127,000	320,000	241,000	375,000	494,000	1,228,000	277,000	810,000
October,	243,000	1,509,000	245,000	282,000	647,000	950,000	689,000	347,000	367,000	530,000	1,382,000
November,	1,283,000	2,170,000	430,000	875,000	517,000	635,000	634,000	343,000	442,000	749,000	2,540,000
December,	2,275,000	2,061,000	359,000	1,570,000	3,234,000	1,848,000	954,000	440,000	1,018,000	794,000	1,961,000
Average,	1,253,000	1,551,000	1,051,000	1,264,000	1,507,000	1,248,000	1,285,000	1,025,000	926,000	1,043,000	1,180,000
Average, driest six months,	886,000	1,013,000	312,000	377,000	576,000	471,000	626,000	413,000	541,000	613,000	725,000

[1] See note at end of this table.

TABLE No. 7. — *Yield of the Wachusett Watershed in Gallons per Day per Square Mile*[1] *from 1897 to 1918* — Concluded.

MONTH.	1908.	1909.	1910.	1911.	1912.	1913.	1914.	1915.	1916.	1917.	1918.	Mean for 22 Years, 1897-1918.
January,	1,738,000	592,000	1,846,000	773,000	780,000	1,414,000	990,000	2,062,000	1,315,000	686,000	484,000	1,177,000
February,	1,736,000	2,556,000	1,845,000	625,000	927,000	867,000	1,181,000	1,961,000	1,816,000	916,000	2,024,000	1,416,000
March,	2,192,000	2,129,000	2,640,000	1,339,000	2,831,000	2,263,000	3,137,000	572,000	1,891,000	2,472,000	3,590,000	2,550,000
April,	1,269,000	2,422,000	1,034,000	1,393,000	2,281,000	2,083,000	2,593,000	926,000	3,300,000	1,468,000	1,608,000	2,115,000
May,	1,415,000	1,212,000	608,000	461,000	1,797,000	1,038,000	1,609,000	455,000	1,697,000	1,317,000	673,000	1,179,000
June,	403,000	632,000	824,000	351,000	331,000	280,000	317,000	228,000	2,054,000	1,229,000	523,000	778,000
July,	220,000	233,000	62,000	57,000	135,000	19,000	329,000	1,063,000	1,086,000	264,000	280,000	429,000
August,	443,000	193,000	186,000	188,000	125,000	60,000	261,000	1,657,000	284,000	309,000	159,000	416,000
September,	88,000	208,000	145,000	181,000	89,000	219,000	—12,000	158,000	294,000	84,000	603,000	329,000
October,	158,000	90,000	68,000	718,000	145,000	678,000	136,000	387,000	140,000	555,000	341,000	482,000
November,	125,000	363,000	354,000	1,035,000	442,000	660,000	211,000	498,000	321,000	313,000	582,000	706,000
December,	387,000	537,000	391,000	1,067,000	798,000	955,000	372,000	1,359,000	460,000	389,000	1,056,000	1,104,000
Average,	847,000	918,000	828,000	682,000	891,000	879,000	934,000	942,000	1,215,000	834,000	902,000	1,055,000
Average, driest six months,	238,000	270,000	201,000	327,000	210,000	318,000	208,000	666,000	432,000	320,000	412,000	522,000

[1] The area of the watershed used in making up these records included water surfaces amounting to 2.2 per cent. of the whole area from 1897 to 1902 inclusive, 2.4 per cent. in 1903, 3.6 per cent. in 1904, 4.1 per cent. in 1905, 5.1 per cent. in 1906, 6.0 per cent. in 1907, 7.0 per cent. in 1908, 1909 and 1910, 6.5 per cent. in 1911, 6.8 per cent. in 1912, 6.9 per cent. in 1913, 7.4 per cent. in 1914 and 1915, 7.6 per cent. in 1916, 7.4 per cent. in 1917, 7.2 per cent. in 1918.

TABLE NO. 8. — *Yield of the Sudbury Watershed in Gallons per Day per Square Mile*[1] *from 1875 to 1918.*

MONTH.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.
January,	103,000	643,000	658,000	1,810,000	700,000	1,120,000	415,000	1,241,000	335,000	995,000	1,235,000
February,	1,496,000	1,368,000	949,000	2,465,000	1,711,000	1,787,000	1,546,000	2,403,000	1,033,000	2,842,000	1,354,000
March,	1,604,000	4,435,000	4,814,000	3,507,000	2,330,000	1,374,000	4,004,000	2,839,000	1,611,000	3,785,000	1,572,000
April,	3,049,000	3,292,000	2,394,000	1,626,000	3,116,000	1,169,000	1,546,000	867,000	1,350,000	2,853,000	1,815,000
May,	1,188,000	1,138,000	1,391,000	1,394,000	1,114,000	514,000	965,000	1,292,000	937,000	1,030,000	1,336,000
June,	870,000	222,000	597,000	506,000	413,000	175,000	1,338,000	529,000	300,000	416,000	426,000
July,	321,000	183,000	202,000	128,000	157,000	176,000	276,000	86,000	115,000	224,000	62,000
August,	396,000	405,000	121,000	476,000	395,000	119,000	148,000	55,000	79,000	257,000	240,000
September,	207,000	184,000	60,000	161,000	141,000	80,000	197,000	307,000	91,000	44,000	121,000
October,	646,000	234,000	631,000	516,000	71,000	102,000	186,000	299,000	186,000	83,000	336,000
November,	1,302,000	1,088,000	1,418,000	1,693,000	206,000	205,000	395,000	209,000	205,000	175,000	1,177,000
December,	584,000	453,000	1,290,000	3,177,000	463,000	175,000	775,000	315,000	194,000	925,000	1,174,000
Average,	972,000	1,135,000	1,214,000	1,452,000	894,000	578,000	979,000	862,000	533,000	1,129,000	901,000
Average, driest six months,	574,000	384,000	502,000	532,000	230,000	143,000	330,000	211,000	145,000	200,000	391,000

[1] See note at end of this table.

TABLE No. 8. — *Yield of the Sudbury Watershed in Gallons per Day per Square Mile*[1] *from 1875 to 1918* — Continued.

Month.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.
January,	1,461,000	2,589,000	1,053,000	2,782,000	1,254,000	3,018,000	1,870,000	434,000	693,000	1,034,000	1,084,000
February,	4,801,000	2,829,000	1,950,000	1,196,000	1,529,000	3,486,000	943,000	1,542,000	991,000	541,000	2,676,000
March,	2,059,000	2,868,000	3,238,000	1,338,000	3,643,000	4,453,000	1,955,000	3,245,000	2,238,000	2,410,000	3,835,000
April,	1,947,000	2,620,000	2,645,000	1,410,000	1,875,000	2,397,000	871,000	2,125,000	1,640,000	2,515,000	1,494,000
May,	720,000	1,009,000	1,632,000	880,000	1,366,000	583,000	1,259,000	2,883,000	840,000	636,000	360,000
June,	203,000	413,000	421,000	653,000	568,000	413,000	428,000	440,000	419,000	174,000	399,000
July,	116,000	115,000	117,000	634,000	107,000	149,000	214,000	158,000	161,000	231,000	95,000
August,	94,000	214,000	379,000	1,432,000	132,000	163,000	280,000	181,000	209,000	229,000	57,000
September,	117,000	111,000	1,155,000	823,000	457,000	203,000	229,000	108,000	150,000	89,000	388,000
October,	146,000	190,000	1,999,000	1,230,000	2,272,000	210,000	126,000	222,000	374,000	1,379,000	592,000
November,	673,000	369,000	2,758,000	1,941,000	1,215,000	305,000	697,000	319,000	836,000	2,777,000	659,000
December,	1,020,000	643,000	3,043,000	2,241,000	996,000	544,000	485,000	796,000	716,000	1,782,000	657,000
Average,	1,087,000	1,154,000	1,697,000	1,383,000	1,285,000	1,315,000	781,000	1,037,000	770,000	1,152,000	1,019,000
Average, driest six months,	223,000	234,000	953,000	944,000	747,000	239,000	327,000	237,000	356,000	460,000	314,000

[1] See note at end of this table.

TABLE NO. 8. — *Yield of the Sudbury Watershed in Gallons per Day per Square Mile*[1] *from 1875 to 1918* — Continued.

MONTH.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.
January,	845,000	1,638,000	2,268,000	794,000	437,000	1,763,000	1,736,000	477,000	1,410,000	1,128,000	1,351,000
February,	1,067,000	3,022,000	1,381,000	3,800,000	300,000	1,674,000	2,279,000	882,000	330,000	1,041,000	624,000
March,	2,565,000	2,604,000	4,205,000	3,654,000	2,755,000	4,199,000	3,454,000	2,999,000	2,497,000	2,409,000	1,658,000
April,	1,515,000	1,829,000	2,521,000	1,350,000	4,204,000	1,885,000	2,261,000	3,294,000	1,643,000	1,949,000	1,607,000
May,	915,000	1,246,000	511,000	1,312,000	2,954,000	743,000	351,000	1,745,000	297,000	1,059,000	888,000
June,	962,000	530,000	66,000	316,000	753,000	303,000	1,987,000	419,000	467,000	707,000	761,000
July,	658,000	231,000	19,000	—18,000	306,000	66,000	445,000	62,000	177,000	398,000	9,000
August,	591,000	1,107,000	—35,000	—34,000	424,000	135,000	307,000	170,000	114,000	180,000	—104,000
September,	182,000	369,000	94,000	65,000	305,000	178,000	130,000	397,000	1,246,000	19,000	541,000
October,	94,000	1,160,000	115,000	186,000	412,000	506,000	492,000	191,000	158,000	301,000	741,000
November,	909,000	1,986,000	304,000	663,000	474,000	444,000	363,000	289,000	279,000	483,000	1,998,000
December,	1,584,000	1,799,000	220,000	1,096,000	2,695,000	1,779,000	582,000	269,000	887,000	659,000	2,032,000
Average,	991,000	1,450,000	973,000	1,082,000	1,342,000	1,140,000	1,190,000	931,000	795,000	860,000	1,010,000
Average, driest six months,	564,000	777,000	93,000	194,000	445,000	271,000	388,000	228,000	403,000	341,000	471,000

[1] See note at end of this table.

TABLE No. 8. — *Yield of the Sudbury Watershed in Gallons per Day per Square Mile*[1] *from 1875 to 1918* — Concluded.

MONTH.	1908.	1909.	1910.	1911.	1912.	1913.	1914.	1915.	1916.	1917.	1918.	Mean for 44 Years, 1875–1918.
January,	1,925,000	392,000	1,490,000	519,000	728,000	1,041,000	908,000	1,629,000	942,000	510,000	273,000	1,153,000
February,	1,536,000	2,286,000	1,849,000	700,000	1,197,000	754,000	1,009,000	1,870,000	1,356,000	755,000	1,809,000	1,658,000
March,	2,257,000	1,734,000	1,954,000	1,144,000	3,092,000	2,090,000	3,029,000	593,000	1,820,000	2,209,000	2,187,000	2,688,000
April,	1,117,000	1,721,000	667,000	1,426,000	2,235,000	2,232,000	2,353,000	590,000	3,037,000	1,405,000	1,466,000	1,976,000
May,	1,046,000	1,004,000	277,000	318,000	1,447,000	867,000	1,550,000	255,000	1,439,000	1,476,000	639,000	1,064,000
June,	194,000	239,000	516,000	213,000	148,000	149,000	5,000	101,000	1,198,000	1,044,000	185,000	491,000
July,	—14,000	—121,000	—102,000	—14,000	—77,000	—62,000	107,000	1,045,000	585,000	43,000	96,000	179,000
August,	102,000	—45,000	—73,000	20,000	—29,000	—54,000	156,000	1,168,000	78,000	202,000	—54,000	236,000
September,	—82,000	149,000	5,000	76,000	—28,000	88,000	—135,000	38,000	26,000	58,000	637,000	222,000
October,	47,000	—51,000	—51,000	296,000	—14,000	484,000	—59,000	231,000	—5,000	482,000	274,000	410,000
November,	71,000	82,000	176,000	593,000	165,000	480,000	97,000	261,000	110,000	438,000	489,000	722,000
December,	136,000	263,000	221,000	908,000	494,000	732,000	250,000	898,000	315,000	380,000	938,000	945,000
Average,	694,000	625,000	570,000	514,000	779,000	733,000	772,000	719,000	904,000	750,000	736,000	975,000
Average, driest six months,	44,000	40,000	29,000	151,000	26,000	180,000	29,000	480,000	186,000	267,000	269,000	375,000

[1] The area of the Sudbury watershed used in these records included water surfaces amounting to 1.9 per cent. of the whole area from 1875 to 1878, inclusive, and was subsequently increased by the construction of storage reservoirs, to 3.0 per cent. in 1879, 3.4 per cent. in 1885, 3.9 per cent. in 1894, and 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

NOTE. — The recorded yields, subsequent to the year 1897, are less accurate than those for previous years, particularly during months of small yield, due to unavoidable inaccuracies in the measurement of large quantities of water received from the Wachusett Reservoir.

TABLE NO. 9. — *Wachusett System. — Statistics of Flow of Water, Storage and Rainfall in 1918.*

[Watershed above dam = 108.84 square miles.]

Month.	Gallons per Day.							Rainfall (Inches).	Rainfall collected (Inches).	Percentage of Rainfall collected.
	Received from City of Worcester Watershed.	Discharged into Wachusett Aqueduct.[1]	Wasted into River below Dam.	Seepage through the North Dike.[2]	Storage.[3] Gain.	Storage.[3] Loss.	Total Yield of Watershed.			
January,	-	134,848,000	4,452,000	835,000	-	87,416,000	52,719,000	2.97	0.864	29.1
February,	-	105,329,000	3,979,000	807,000	110,121,000	-	220,236,000	4.25	3.260	76.6
March,	11,021,000	60,485,000	3,395,000	891,000	228,158,000	-	281,908,000	2.24	4.614	206.0
April,	8,073,000	103,930,000	2,523,000	957,000	75,630,000	-	174,967,000	3.47	2.775	80.0
May,	-	105,168,000	2,942,000	974,000	-	35,807,000	73,277,000	1.07	1.201	112.8
June,	-	139,197,000	2,663,000	947,000	-	85,900,000	56,907,000	4.57	0.902	19.8
July,	-	132,174,000	2,861,000	913,000	-	105,509,000	30,439,000	2.80	0.499	17.8
August,	-	134,622,000	3,245,000	881,000	-	121,445,000	17,303,000	2.82	0.284	10.1
September,	-	96,867,000	3,408,000	830,000	-	35,480,000	65,630,000	7.18	1.041	14.5
October,	-	92,919,000	2,745,000	809,000	-	59,352,000	37,121,000	1.58	0.609	38.6
November,	-	101,863,000	1,827,000	800,000	-	41,170,000	63,320,000	3.08	1.004	32.6
December,	-	96,437,000	1,758,000	787,000	15,983,000	-	114,965,000	3.74	1.884	50.4
Total,	-	-	-	-	-	-	-	39.77	18.937	-
Average for year,	1,598,000	108,667,000	2,978,000	870,000	-	12,779,000	98,138,000	-	-	47.6

[1] Including 164,000 gallons per day drawn from aqueduct for the supply of the Westborough State Hospital.
[2] Estimated.
[3] Aggregate storage in Wachusett Reservoir and in ponds and mill reservoirs.

TABLE NO. 10. — *Sudbury System. — Statistics of Flow of Water, Storage and Rainfall in 1918.*

[Watershed = 75.2 square miles.]

MONTH.	GALLONS PER DAY.									Rainfall (Inches).	Rainfall collected (Inches).	Percentage of Rainfall collected.
	Water received from Wachusett Reservoir.[1]	Water discharged through Sudbury Aqueduct.	Water discharged through Weston Aqueduct.	Water used by Framingham Water Works.	Water diverted from Watershed by Sewers, etc.	Water wasted into River below Lowest Dam.	STORAGE.		Total Yield of Watershed.			
							Gain.	Loss.				
January, . .	134,684,000	92,297,000	48,471,000	1,452,000	906,000	14,223,000	-	2,165,000	20,500,000	3.47	0.486	14.0
February, .	105,154,000	85,218,000	63,754,000	1,682,000	1,747,000	68,032,000	20,732,000	-	136,011,000	3.58	2.914	81.3
March, . .	60,317,000	68,360,000	67,804,000	1,357,000	1,887,000	104,482,000	-	19,116,000	164,457,000	2.50	3.896	156.2
April, . .	103,757,000	67,850,000	49,070,000	993,000	1,687,000	66,017,000	28,347,000	-	110,207,000	4.43	2.530	57.1
May, . .	105,026,000	75,274,000	45,055,000	1,171,000	1,097,000	31,023,000	-	507,000	48,087,000	1.16	1.141	98.8
June, . .	139,023,000	82,060,000	42,160,000	1,117,000	766,000	10,654,000	16,170,000	-	13,903,000	3.65	0.319	8.7
July, . .	131,997,000	79,622,000	45,865,000	1,126,000	642,000	6,655,000	5,322,000	-	7,235,000	4.07	0.171	4.2
August, . .	134,465,000	84,255,000	43,777,000	1,110,000	600,000	2,932,000	-	2,267,000	—4,058,000	1.61	—0.096	—6.0
September, .	96,707,000	68,750,000	47,333,000	1,057,000	1,134,000	22,123,000	4,240,000	-	47,930,000	8.60	1.100	12.8
October, . .	92,778,000	62,586,000	52,548,000	1,169,000	1,462,000	14,592,000	-	18,955,000	20,624,000	1.04	0.490	47.0
November, .	101,713,000	65,570,000	50,113,000	1,013,000	1,080,000	32,500,000	-	11,823,000	36,740,000	2.75	0.843	30.7
December, .	96,284,000	64,329,000	51,058,000	877,000	1,110,000	47,132,000	2,307,000	-	70,529,000	3.68	1.673	45.5
Total, .	-	-	-	-	-	-	-	-	-	40.54	15.467	-
Av. for year,	108,503,000	74,633,000	50,512,000	1,174,000	1,172,000	34,773,000	1,621,000	-	55,382,000	-	-	38.2

[1] Not including 164,000 gallons per day drawn from the Wachusett Aqueduct for the supply of the Westborough State Hospital, which were not discharged into Sudbury Reservoir.

TABLE No. 11. — *Cochituate System. — Statistics of Flow of Water, Storage and Rainfall in 1918.*

[Watershed of lake=17.58 square miles.[1]]

MONTH.	GALLONS PER DAY.						Rainfall (Inches).	Rainfall collected (Inches).	Percentage of Rainfall collected.
	Water discharged through Cochituate Aqueduct.	Water diverted from Watershed by Sewers, etc.	Water wasted at Outlet of Lake.	STORAGE.		Total Yield of Watershed.			
				Gain.	Loss.				
January,	1,200,000	416,000	5,668,000	1,619,000	-	8,903,000	3.26	0.91	27.7
February,	4,189,000	511,000	20,364,000	6,154,000	-	31,218,000	3.80	2.86	75.3
March,	-	885,000	34,786,000	-	2,607,000	33,064,000	2.26	3.35	143.3
April,	-	1,440,000	6,987,000	14,923,000	-	23,350,000	4.61	2.29	49.7
May,	-	1,061,000	9,484,000	190,000	-	10,755,000	1.10	1.09	99.2
June,	-	627,000	1,213,000	1,823,000	-	3,663,000	3.34	0.36	10.8
July,	-	516,000	2,410,000	-	78,000	2,848,000	3.64	0.29	7.9
August,	-	426,000	161,000	-	1,152,000	—565,000	1.41	—0.06	—4.1
September,	-	727,000	12,440,000	1,030,000	-	14,197,000	8.58	1.40	16.2
October,	-	937,000	5,344,000	-	457,000	5,824,000	0.92	0.59	64.3
November,	-	893,000	13,430,000	-	4,423,000	9,900,000	2.57	0.97	37.8
December,	-	1,313,000	22,532,000	-	5,397,000	18,448,000	3.55	1.87	52.7
Total,	-	-	-	-	-	-	39.04	15.92	-
Average for year,	423,000	816,000	11,186,000	901,000	-	13,326,000	-	-	40.8

[1] Not including the watersheds of Dudley and Dug ponds.

TABLE NO. 12. — *Elevations of Water Surfaces of Reservoirs above Boston City Base at the Beginning of Each Month.*

DATE.	Chestnut Hill Reservoir. Ordinary High Water =134.00.	Lake Cochituate. High Water =144.36.	Farm Pond. High Water =159.25.	Spot Pond. High Water =163.00.	Weston Reservoir. High Water =200.00.	FRAMINGHAM RESERVOIR. No. 1. Flash Boards 169.32.	FRAMINGHAM RESERVOIR. No. 2. Flash Boards 177.12.	FRAMINGHAM RESERVOIR. No. 3. Flash Boards 186.50.	Ashland Reservoir. Flash Boards 225.23.	Sudbury Reservoir. Flash Boards 259.97.	Hopkinton Reservoir. Flash Boards 305.00.	Whitehall Reservoir. Ordinary High Water =337.91.	Wachusett Reservoir. Ordinary High Water =395.00.
Jan. 1, 1918,	132.52	141.91	157.75	162.05	198.41	167.71	176.02	183.25	223.59	257.52	303.30	336.79	385.94
Feb. 1, 1918,	132.46	141.79	158.20	160.88	199.74	167.66	176.02	183.73	223.28	257.64	302.49	336.23	383.63
Mar. 1, 1918,	133.74	142.54	158.67	160.64	199.82	168.31	176.66	185.25	224.44	258.17	303.27	336.50	385.91
Apr. 1, 1918,	133.81	142.19	158.70	162.56	199.66	167.94	176.34	184.19	224.49	256.62	304.19	336.92	391.53
May 1, 1918,	133.56	144.09	158.75	163.17	199.11	167.97	176.40	183.93	225.40	258.31	305.13	337.36	393.29
June 1, 1918,	133.66	144.13	158.28	163.15	199.09	169.40	177.33	184.16	225.27	257.91	305.04	337.61	392.53
July 1, 1918,	133.81	144.36	158.79	163.25	198.29	169.43	177.26	184.50	225.22	258.93	305.02	337.76	390.60
Aug. 1, 1918,	133.98	144.35	158.41	163.12	199.77	169.39	177.21	185.45	225.25	259.19	304.95	337.80	388.16
Sept. 1, 1918,	133.92	144.20	158.11	163.48	200.42	169.37	177.16	186.08	225.08	259.10	304.75	337.58	385.21
Oct. 1, 1918,	134.40	144.33	158.49	163.44	197.98	169.60	177.44	185.52	225.31	259.20	305.04	337.87	384.23
Nov. 1, 1918,	133.81	144.27	158.20	163.04	199.61	169.44	177.27	185.34	225.30	257.87	305.02	337.85	382.68
Dec. 1, 1918,	134.03	143.71	158.05	163.15	200.02	167.76	176.08	184.80	224.33	257.81	304.11	337.69	381.52
Jan. 1, 1919,	133.85	142.91	158.12	163.07	199.92	167.87	176.20	185.09	224.50	258.24	304.18	336.90	381.88

TABLE No. 13. — *Sources from which and Periods during which Water has been drawn for the Supply of the Metropolitan Water District.*

From Wachusett Reservoir into the Wachusett Aqueduct.

Month.	Number of Days during which Water was flowing.	Actual Time.		Million Gallons drawn.
		Hours.	Minutes.	
January,	26	292	4	4,180.3
February,	22	241	50	2,949.2
March,	26	231	40	1,872.5
April,	26	236	5	3,117.9
May,	26	251	25	3,261.2
June,	25	288	45	4,175.9
July,	26	301	49	4,097.4
August,	27	293	50	4,173.3
September,	22	226	6	2,906.0
October,	24	219	-	2,884.4
November,	23	208	35	3,055.9
December,	25	234	55	2,989.5
Totals,	298	3,020	364	39,663.5

Total actual time, 126.09 days.
Total quantity drawn, 39,663,500,000 gallons.

From Sudbury Reservoir through the Weston Aqueduct to Weston Reservoir.

Month.	Number of Days during which Water was flowing.	Actual Time.		Million Gallons drawn.
		Hours.	Minutes.	
January,	26	353	49	1,502.6
February,	28	406	5	1,785.1
March,	31	471	46	2,099.1
April,	26	372	50	1,472.1
May,	26	361	1	1,396.7
June,	25	325	00	1,264.8
July,	26	355	44	1,421.8
August,	26	354	58	1,357.1
September,	24	364	10	1,420.0
October,	26	386	28	1,631.2
November,	25	377	00	1,503.4
December,	25	376	20	1,582.8
Totals,	314	4,505	11	18,436.7

Total actual time, 187.72 days.
Total quantity drawn, 18,436,700,000 gallons.

TABLE No. 13 — *Concluded.*

From Framingham Reservoir No. 3 through the Sudbury Aqueduct to Chestnut Hill Reservoir.

MONTH.	Number of Days during which Water was flowing.	Actual Time (Hours).	Million Gallons drawn.
January,	31	744	2,861.2
February,	28	672	2,386.1
March,	31	743	2,116.3
April,	30	720	2,035.5
May,	31	744	2,333.5
June,	30	711	2,461.8
July,	31	744	2,468.3
August,	31	744	2,611.9
September,	30	720	2,062.5
October,	31	745	1,942.8
November,	30	720	1,967.1
December,	31	744	1,994.2
Totals,	365	8,751	27,241.2

Total actual time, 364.63 days.
Total quantity drawn, 27,241,200,000 gallons.

TABLE No. 14. — *Average Daily Quantity of Water flowing through Aqueduct in 1918 by Months.*[1]

MONTH.	Wachusett Aqueduct into Sudbury Reservoir (Gallons).	Weston Aqueduct into Metropolitan District (Gallons).	Sudbury Aqueduct into Chestnut Hill Reservoir (Gallons).	Cochituate Aqueduct into Chestnut Hill Reservoir (Gallons).
January,	134,684,000	48,471,000	92,297,000	1,200,000
February,	105,154,000	63,754,000	85,218,000	4,189,000
March,	60,317,000	67,804,000	68,360,000	-
April,	103,757,000	49,070,000	67,850,000	-
May,	105,026,000	45,055,000	75,274,000	-
June,	139,023,000	42,160,000	82,060,000	-
July,	131,997,000	45,865,000	79,622,000	-
August,	134,465,000	43,777,000	84,255,000	-
September,	96,707,000	47,333,000	68,750,000	-
October,	92,778,000	52,548,000	62,586,000	-
November,	101,713,000	50,113,000	65,570,000	-
December,	96,284,000	51,058,000	64,329,000	-
Average,	108,503,000	50,512,000	74,633,000	423,000

[1] Not including quantities wasted while cleaning and repairing aqueducts.

TABLE NO. 15. — *Statement of Operations of Engines Nos. 1, 2, 3 and 4 at Chestnut Hill Pumping Station No. 1 for the Year 1918.*

MONTH.	ENGINE NO. 1.			ENGINE NO. 2.			ENGINE NO. 3.			ENGINE NO. 4.			Total Quantity pumped. Corrected for Slip (Million Gallons).	Daily Average Quantity pumped. Corrected for Slip (Million Gallons).	Coal consumed in pumping (Pounds).	Coal used in banking (Pounds).	Per Cent. of Ashes and Clinkers.
	Total Pumping Time.	Quantity pumped, 3 Per Cent. allowed for Slip (Million Gallons).	Average Lift (Feet).	Total Pumping Time.	Quantity pumped, 3 Per Cent. allowed for Slip (Million Gallons).	Average Lift (Feet).	Total Pumping Time.	Quantity pumped, 4.4 Per Cent allowed for Slip (Million Gallons).	Average Lift (Feet).	Total Pumping Time.	Quantity Pumped, 2 Per Cent. allowed for Slip (Million Gallons).	Average Lift (Feet).					
	Hrs. Min.			Hrs. Min.			Hrs. Min.			Hrs. Min.							
January,	482 30	168.82	132.12	101 45	85.86	132.95	- -	-	-	64 30	80.06	122.59	284.74	9.185	545,378	62,400	22.0
February,	287 00	101.23	131.48	288 35	101.24	130.94	- -	-	-	74 20	93.46	125.10	295.93	10.569	575,227	23,095	21.1
March,	359 25	129.38	131.85	48 00	17.48	131.74	- -	-	-	4 45	6.41	126.29	153.27	4.944	296,490	58,645	20.2
April,	260 15	90.32	133.16	67 05	24.17	133.82	- -	-	-	23 00	28.82	125.08	143.31	4.777	275,260	55,785	15.5
May,	263 00	93.30	134.24	36 25	13.03	134.23	- -	-	-	- -	-	-	106.33	3.430	226,291	35,405	18.0
June,	243 20	87.57	134.36	64 40	22.99	134.35	- -	-	-	- -	-	-	110.56	3.685	242,155	43,875	19.8
July,	- -	-	-	320 00	114.32	133.71	- -	-	-	12 40	16.05	124.47	130.37	4.205	260,845	53,180	19.7
August,	179 20	64.46	133.06	146 00	52.52	133.24	- -	-	-	19 30	21.77	122.92	138.75	4.476	239,450	48,905	20.9
September,	88 50	31.67	133.47	209 25	74.02	133.64	- -	-	-	- -	-	-	105.69	3.523	236,394	37,310	20.0
October,	- -	-	-	241 50	85.77	133.74	- -	-	-	34 55	38.23	123.83	124.00	4.000	265,942	28,711	16.1
November,	- -	-	-	355 45	119.86	133.12	- -	-	-	- -	-	-	119.86	3.995	307,084	59,575	16.3
December,	- -	-	-	331 55	110.28	133.32	- -	-	-	- -	-	-	110.28	3.557	250,455	57,900	13.9
Total,	2,163 40	766.75	-	2,211 25	771.54	-	- -	-	-	233 40	284.80	-	1,823.09	-	3,729,971	564,786	-
Average,	- -	-	132.76	- -	-	133.12	- -	-	-	- -	-	124.05	-	4.995	-	-	19.0

TABLE NO. 16. — *Statement of Operations of Engines Nos. 5, 6, 7 and 12 at Chestnut Hill Pumping Station No. 2 for the Year 1918.*

MONTH.	ENGINE NO. 5.			ENGINE NO. 6.			ENGINE NO. 7.			ENGINE NO. 12.			Total Quantity pumped, 2 Per Cent. allowed for Slip (Million Gallons).	Daily Average Quantity pumped, 2 Per Cent. allowed for Slip (Million Gallons).	Total Coal consumed in pumping and banking (Pounds).	Per Cent. of Ashes and Clinkers.
	Total Pumping Time.	Quantity pumped, 2 Per Cent. allowed for Slip (Million Gallons).	Average Lift (Feet).	Total Pumping Time.	Quantity pumped, 2 Per Cent. allowed for Slip (Million Gallons).	Average Lift (Feet).	Total Pumping Time.	Quantity pumped, 2 Per Cent. allowed for Slip (Million Gallons).	Average Lift (Feet).	Total Pumping Time.	Quantity pumped, 2 Per Cent. allowed for Slip (Million Gallons).	Average Lift (Feet).				
	Hrs. Min.			Hrs. Min.			Hrs. Min.			Hrs. Min.						
January,	603 25	610.04	31.14	744 00	756.60	29.07	5 05	4.14	35.64	718 15	1,168.68	124.72	2,539.46	81.918	1,697,880	24.5
February,	669 05	723.32	53.05	618 25	671.15	52.29	86 25	82.62	48.02	670 35	1,085.23	124.39	2,562.32	91.511	1,760,280	20.5
March,	741 30	758.04	61.03	743 00	759.63	61.05	- -	-	-	743 00	1,207.97	123.15	2,725.64	87.924	1,844,434	19.5
April,	364 50	390.39	38.33	622 10	671.44	34.50	- -	-	-	702 00	1,062.91	122.12	2,124.74	70.825	1,326,890	28.3
May,	332 10	337.69	33.99	744 00	775.52	28.39	10 45	9.91	34.59	744 00	1,162.57	121.96	2,285.69	73.732	1,346,380	33.6
June,	107 30	117.82	31.88	567 00	594.81	30.17	461 30	501.77	29.37	720 00	1,154.42	121.74	2,368.82	78.961	1,319,575	30.4
July,	- -	-	-	364 05	365.10	33.12	744 00	787.29	28.49	739 30	1,178.35	121.79	2,330.74	75.185	1,400,236	23.4
August,	21 15	21.11	34.27	585 15	600.65	30.41	637 05	649.42	29.24	744 00	1,196.63	122.10	2,467.81	79.607	1,619,558	26.1
September,	- -	-	-	193 00	174.74	34.38	679 40	655.97	28.03	720 00	1,170.69	121.54	2,001.40	66.713	1,338,220	18.1
October,	38 25	29.36	35.34	86 10	86.38	34.87	632 45	641.66	27.95	637 30	1,191.08	122.30	1,948.48	62.854	1,301,792	19.5
November,	- -	-	-	43 05	37.86	36.60	714 30	742.58	27.99	720 00	1,108.87	121.68	1,889.31	62.977	1,212,348	23.0
December,	- -	-	-	159 35	154.09	34.67	630 35	640.65	28.39	744 00	1,184.81	121.86	1,979.55	63.856	1,325,945	24.1
Total,	2,878 10	2,987.77	-	5,469 45	5,647.97	-	4,602 20	4,716.01	-	8,602 50	13,872.21	-	27,223.96	-	17,493,533	-
Average,	- -	-	45.38	- -	-	37.66	- -	-	28.82	- -	-	122.44	-	74.586	-	24.1

TABLE No. 17. — *Statement of Operation of Engine No. 8 at Spot Pond Pumping Station for the Year 1918.*

MONTH.	Total Pumping Time. Hrs.	Total Pumping Time. Min.	Quantity pumped, 2 Per Cent. allowed for Slip (Million Gallons).	Coal consumed in pumping and banking (Pounds).	Ashes and Clinker (Pounds).	Per Cent. of Ashes and Clinker.	Gallons pumped per Pound of Coal, 2 Per Cent. allowed for Slip. No Deduction for Heating or Lighting.	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal, 2 Per Cent. allowed for Slip. No Deduction for Heating or Lighting.	Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement. No Deduction for Heating or Lighting.
January,	-	-	-	-	-	-	-	-	-	-
February,	-	-	-	-	-	-	-	-	-	-
March,	-	-	-	-	-	-	-	-	-	-
April,	1	15	0.46	660	120	18.0	696.97	110.86	64,360,000	65,690,000
May,	-	-	-	-	-	-	-	-	-	-
June,	-	-	-	-	-	-	-	-	-	-
July,	-	-	-	-	-	-	-	-	-	-
August,	-	-	-	-	-	-	-	-	-	-
September,	-	-	-	-	-	-	-	-	-	-
October,	-	-	-	-	-	-	-	-	-	-
November,	179	35	77.45	114,495	20,590	18.0	676.45	122.78	69,180,000	70,610,000
December,	150	05	64.63	68,660	9,990	14.5	941.30	122.14	95,770,000	97,740,000
Total,	330	55	142.54	183,815	30,700	-	-	-	-	-
Average,	-	-	-	-	-	16.7	775.45	122.45	79,100,000	80,730,000

TABLE No. 18. — *Statement of Operation of Engine No. 9 at Spot Pond Pumping Station for the Year 1918.*

MONTH.	Total Pumping Time. Hrs.	Total Pumping Time. Min.	Quantity pumped, 2 Per Cent. allowed for Slip (Million Gallons).	Coal consumed in pumping and banking (Pounds).	Ashes and Clinker (Pounds).	Per Cent. of Ashes and Clinker.	Gallons pumped per Pound of Coal, 2 Per Cent. allowed for Slip. No Deduction for Heating or Lighting.	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal, 2 Per Cent. allowed for Slip. No Deduction for Heating or Lighting.	Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement. No Deduction for Heating or Lighting.	Summary of Engines Nos. 8 and 9. Total Quantity pumped, 2 Per Cent. allowed for Slip (Million Gallons).	Summary of Engines Nos. 8 and 9. Daily Average Quantity pumped, 2 Per Cent. allowed for Slip (Million Gallons).
January,	358	30	298.52	354,614	71,675	20.2	841.82	132.49	92,910,000	94,800,000	298.52	9.630
February,	438	55	366.53	420,215	73,290	17.4	872.24	134.37	97,630,000	99,610,000	366.53	13.090
March,	413	00	347.47	400,848	74,895	18.7	866.84	134.55	97,160,000	99,130,000	347.47	11.209
April,	326	40	273.79	296,311	52,331	17.7	924.00	135.67	104,420,000	106,540,000	274.25	9.142
May,	343	55	288.71	312,240	58,090	18.6	924.64	131.50	101,280,000	103,340,000	288.71	9.313
June,	341	25	288.63	315,005	68,995	21.9	916.27	130.45	99,570,000	101,590,000	288.63	9.621
July,	370	55	311.09	344,300	65,380	19.0	903.54	129.83	97,720,000	99,700,000	311.09	10.035
August,	350	15	295.48	302,962	56,150	18.5	975.30	129.94	105,570,000	107,710,000	295.48	9.532
September,	320	20	267.29	306,398	61,535	20.1	872.36	130.15	94,580,000	96,500,000	267.29	8.910
October,	311	25	261.76	312,901	62,200	19.9	836.24	130.93	91,200,000	93,050,000	261.76	8.444
November,	193	15	161.05	206,030	34,745	16.9	781.68	132.95	86,570,000	88,330,000	238.50	7.950
December,	204	50	171.84	191,158	29,060	15.2	898.94	133.96	100,310,000	102,350,000	236.47	7.628
Total,	3,973	25	3,332.16	3,762,962	708,346	-	-	-	-	-	3,474.70	-
Average,	-	-	-	-	-	18.8	885.51	132.22	97,530,000	99,510,000	-	9.520

TABLE No. 19. — *Statement of Operation of Engine No. 10 at Arlington Pumping Station for the Year 1918.*

Month.	Total Pumping Time. Hrs.	Total Pumping Time. Min.	Quantity pumped, 2 Per Cent. allowed for Slip (Million Gallons).	Coal consumed in pumping and banking (Pounds).	Ashes and Clinker (Pounds).	Per Cent. of Ashes and Clinker.	Gallons pumped per Pound of Coal, 2 Per Cent. allowed for Slip. No Deduction for Heating or Lighting.	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal, 2 Per Cent. allowed for Slip. No Deduction for Heating or Lighting.	Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement. No Deduction for Heating or Lighting.
January,	597	00	29.06	149,405	37,066	24.8	194.50	282.94	45,840,000	46,630,000
February,	647	30	35.78	155,785	37,728	24.2	229.68	288.89	55,270,000	56,230,000
March,	675	45	36.34	152,150	36,777	24.2	238.84	286.47	56,990,000	57,980,000
April,	603	15	30.33	154,244	36,817	23.9	196.64	281.91	46,180,000	46,980,000
May,	622	50	32.61	140,949	28,314	20.1	231.36	282.17	54,380,000	55,320,000
June,	603	00	32.48	123,850	24,088	19.4	262.25	283.32	61,890,000	62,960,000
July,	627	45	33.61	142,190	27,835	19.6	236.37	283.43	55,810,000	56,780,000
August,	637	00	33.48	157,124	25,481	16.2	213.08	280.01	49,700,000	50,560,000
September,	571	35	29.35	126,233	25,982	20.6	232.51	279.61	54,160,000	55,100,000
October,	688	05	26.41	114,185	19,699	17.2	231.29	278.12	53,580,000	54,510,000
November,	706	05	24.10	106,523	18,606	17.5	226.24	277.51	52,300,000	53,200,000
December,	721	00	24.13	126,990	34,185	26.9	190.01	277.43	43,910,000	44,670,000
Total,	7,700	50	367.68	1,649,628	352,578	-	-	-	-	-
Average,	-	-	-	-	-	21.4	222.89	282.20	52,400,000	53,310,000

TABLE No. 20. — *Statement of Operation of Engine No. 11, at Arlington Pumping Station for the Year 1918.*

Month.	Total Pumping Time. Hrs.	Total Pumping Time. Min.	Quantity pumped, 4 Per Cent. allowed for Slip (Million Gallons).	Coal consumed in pumping and banking (Pounds).	Ashes and Clinker (Pounds).	Per Cent. of Ashes and Clinker.	Gallons pumped per Pound of Coal, 4 Per Cent. allowed for Slip. No Deduction for Heating or Lighting.	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal, 4 Per Cent. allowed for Slip. No Deduction for Heating or Lighting.	Duty in Foot-pounds per 100 Pounds of Coal on Basis of Plunger Displacement. No Deduction for Heating or Lighting.
January,	-	-	-	-	-	-	-	-	-	-
February,	-	-	-	-	-	-	-	-	-	-
March,	-	-	-	-	-	-	-	-	-	-
April,	-	-	-	-	-	-	-	-	-	-
May,	2	15	0.11	660	135	20.5	166.67	280.80	38,990,000	40,800,000
June,	-	-	-	-	-	-	-	-	-	-
July,	-	-	-	-	-	-	-	-	-	-
August,	-	-	-	-	-	-	-	-	-	-
September,	-	-	-	-	-	-	-	-	-	-
Octobe ,	-	-	-	-	-	-	-	-	-	-
November,	-	-	-	-	-	-	-	-	-	-
December,	-	-	-	-	-	-	-	-	-	-
Total,	2	15	0.11	660	135	-	-	-	-	-
Average,	-	-	-	-	-	20.5	166.67	280.80	38,990,000	40,800,000

TABLE No. 21. — *Statement of Operation of Engine No. 15 and Summary of Engines at Arlington Pumping Station for the Year 1918.*

Month.	Total Pumping Time. Hrs.	Total Pumping Time. Min.	Quantity pumped, Venturi Meter Measurement (Million Gallons).	Coal consumed in pumping and banking (Pounds).	Ashes and Clinker (Pounds).	Per Cent. of Ashes and Clinker.	Gallons pumped per Pound of Coal, Venturi Meter Measurement. No Deduction for Heating or Lighting.	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal. No Deduction for Heating or Lighting.	Summary of Engines Nos. 10, 11 and 15. Total Quantity pumped. Corrected for Slip (Million Gallons).	Summary of Engines Nos. 10, 11 and 15. Daily Average Quantity pumped. Corrected for Slip (Million Gallons).
January,	-	-	-	-	-	-	-	-	-	29.06	0.937
February,	-	-	-	-	-	-	-	-	-	35.78	1.278
March,	-	-	-	-	-	-	-	-	-	36.34	1.172
April,	-	-	-	-	-	-	-	-	-	30.33	1.011
May,	29	50	2.61	9,026	1,920	21.3	289.15	299.40	72,110,000[1]	35.33	1.140
June,	76	15	3.89	24,015	7,350	30.6	161.94	280.90	37,890,000	36.37	1.212
July,	33	30	1.91	12,175	2,335	19.2	156.88	287.33	37,550,000	35.52	1.146
August,	-	-	-	-	-	-	-	-	-	33.48	1.080
September,	-	-	-	-	-	-	-	-	-	29.35	0.978
October,	-	-	-	-	-	-	-	-	-	26.41	0.852
November,	6	00	0.42	2,965	588	19.8	141.65	277.15	32,700,000	24.52	0.817
December,	-	-	-	-	-	-	-	-	-	24.13	0.778
Total,	145	35	8.83	48,181	12,193	-	-	-	-	376.62	-
Average,	-	-	-	-	-	25.3	183.27	287.59	43,900,000	-	1.032

[1] Duty trials, no heating or lighting.

TABLE No. 22. — *Statement of Operation of Engines Nos. 13 and 14 at Hyde Park Pumping Station for the Year 1918.*

Month.	Engine No. 13. Total Pumping Time. Hrs.	Min.	Engine No. 13. Quantity pumped, 2 Per Cent. allowed for Slip (Million Gallons).	Engine No. 14. Total Pumping Time. Hrs.	Min.	Engine No. 14. Quantity pumped, 2 Per Cent. allowed for Slip (Million Gallons).	Total Quantity pumped, 2 Per Cent. allowed for Slip (Million Gallons).	Total Coal consumed in pumping and banking (Pounds).	Total Ashes and Clinker (Pounds).	Per Cent. of Ashes and Clinker.	Gallons pumped per Pound of Coal, 2 Per Cent. allowed for Slip. No Deduction for Heating or Lighting.	Average Lift (Feet). Engine No. 13.	Average Lift (Feet). Engine No. 14.	Duty in Foot-pounds per 100 Pounds of Coal, 2 Per Cent. allowed for Slip. No Deduction for Heating or Lighting.	Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement. No Deduction for Heating or Lighting.
January,	443	40	23.38	-	-	-	23.38	68,137	12,176	17.9	343.13	135.29	-	38,670,000	39,500,000
February,	435	40	23.29	11	20	0.72	24.01	62,438	11,302	18.1	384.54	136.84	140.00	43,870,000	44,810,000
March,	476	55	25.95	-	-	-	25.95	67,242	13,173	19.6	385.92	135.38	-	43,520,000	44,460,000
April,	406	45	22.38	15	57	0.90	23.28	69,807	19,382	27.8	333.49	135.00	134.97	37,500,000	38,310,000
May,	462	00	26.62	-	-	-	26.62	74,233	19,073	25.7	358.60	136.29	-	40,710,000	41,590,000
June,	307	40	8.69	134	00	19.63	28.32	72,519	18,221	25.1	390.52	138.17	138.87	45,120,000	46,090,000
July,	-	-	-	431	50	27.42	27.42	66,261	12,904	19.5	413.82	-	138.54	47,760,000	48,790,000
August,	-	-	-	407	10	25.95	25.95	65,332	12,770	19.5	397.20	-	138.57	45,850,000	46,840,000
September,	-	-	-	383	20	23.49	23.49	60,329	13,169	21.8	389.36	-	137.85	44,710,000	45,670,000
October,	-	-	-	393	55	23.37	23.37	64,678	15,690	24.3	361.33	-	137.63	41,420,000	42,310,000
November,	336	10	21.10	23	40	1.46	22.56	60,680	13,280	21.9	371.79	137.51	137.95	42,610,000	43,530,000
December,	345	35	21.65	-	-	-	21.65	60,562	14,087	23.3	357.48	138.84	-	41,340,000	42,230,000
Total,	3,214	25	178.06	1,801	12	122.94	296.00	792,218	175,236	-	-	-	-	-	-
Average,	-	-	-	-	-	-	-	-	-	22.1	373.63	136.49	138.27	42,710,000	43,630,000

TABLE No. 23. — (*Meter Basis.*) *Average Daily Consumption of Water by Districts in the Cities and Towns supplied by the Metropolitan Water Works in 1918. (For Consumption of Water in Whole Metropolitan Water District, see Table No. 25.)*

MONTH.	SOUTHERN LOW SERVICE. Boston, excluding East Boston and Charlestown (Gallons).	NORTHERN LOW SERVICE. Portions of Charlestown, Somerville, Chelsea, Everett, Malden, Medford, East Boston and Arlington (Gallons).	SOUTHERN HIGH SERVICE. Quincy, Watertown, and Portions of Boston, Belmont and Milton (Gallons).	NORTHERN HIGH SERVICE. Revere, Winthrop, Swampscott, Nahant, Stoneham, Melrose, and Portions of Boston, Chelsea, Everett, Malden, Medford and Somerville (Gallons.)	SOUTHERN EXTRA HIGH SERVICE. Portions of Boston and Milton (Gallons).	NORTHERN EXTRA HIGH SERVICE. Lexington and Portions of Arlington and Belmont (Gallons).	Total District supplied (Gallons).	Estimated Population.	Consumption per Inhabitant (Gallons).
January,	55,634,300	31,485,100	45,326,300	10,377,100	727,700	976,700	144,527,200	1,228,650	118
February,	57,642,400	34,994,900	51,456,700	13,569,900	837,800	1,331,300	159,833,000	1,230,790	130
March,	48,179,600	29,428,100	45,834,900	11,549,400	824,800	1,224,900	137,041,700	1,232,920	111
April,	45,295,500	25,279,400	41,647,100	9,829,800	766,800	1,067,300	123,885,900	1,235,060	100
May,	45,475,400	25,075,000	42,894,100	9,744,900	851,500	1,138,800	125,179,700	1,237,190	101
June,	45,295,300	25,755,500	44,081,600	10,099,700	941,200	1,260,200	127,433,500	1,239,330	103
July,	45,066,900	25,591,400	44,249,700	10,598,800	885,300	1,184,500	127,576,600	1,241,460	103
August,	45,847,400	25,023,300	45,226,900	10,229,400	825,300	1,122,200	128,274,500	1,243,600	103
September,	45,867,400	24,005,700	44,108,100	9,200,900	753,200	1,018,000	124,953,300	1,245,730	100
October,	43,013,400	23,408,500	43,695,900	8,674,700	722,100	888,400	120,403,000	1,247,870	96
November,	42,066,300	23,407,300	43,175,000	8,344,200	733,500	842,800	118,569,100	1,250,000	95
December,	43,432,600	24,281,100	44,367,800	8,060,800	659,600	817,400	121,619,300	1,252,140	97
For the year,	46,838,000	26,428,300	44,631,800	10,001,500	793,600	1,070,800	129,764,000	1,241,460	105

In addition to the above quantities the United States Government Reservation on Peddock's Island was supplied with 49,246,000 gallons, equivalent to a daily average rate of 134,900 gallons, and a part of Saugus with 16,377,000 gallons, equivalent to a daily average rate of 44,900 gallons.

TABLE NO. 24. — (*Meter Basis.*) *Average Daily Consumption of Water in Cities and Towns supplied by the Metropolitan Water Works in 1918.*

City or town,	ARLINGTON.		BELMONT.		BOSTON.		CHELSEA.		EVERETT.		LEXINGTON.		MALDEN.	
Population,	16,910.		9,330.		790,330.		47,570.		40,700.		5,900.		52,150.	
	GALLONS.		GALLONS.		GALLONS.		GALLONS.		GALLONS.		GALLONS.		GALLONS.	
MONTH.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.
January,	1,121,100	68	534,400	58	107,582,900	137	4,306,700	92	4,582,700	114	451,700	77	3,065,400	59
February,	1,739,900	104	786,500	86	114,496,900	146	4,402,500	94	5,065,700	126	664,600	114	4,161,300	80
March,	1,646,500	99	628,200	68	97,096,100	124	3,708,000	79	3,803,700	94	622,900	106	4,208,000	81
April,	1,218,300	73	531,800	58	89,692,100	114	3,219,800	68	3,213,900	79	507,900	87	3,524,700	68
May,	1,326,400	79	577,700	62	90,897,800	115	3,302,300	70	3,064,300	76	540,700	92	3,270,200	63
June,	1,489,800	88	616,900	66	92,254,100	117	3,460,800	73	3,045,900	75	551,300	94	3,128,000	60
July,	1,419,200	84	572,300	61	92,368,900	117	3,681,200	77	3,058,300	75	527,700	89	3,112,400	60
August,	1,271,400	75	577,300	62	93,654,800	118	3,211,800	67	3,075,200	75	516,800	87	3,158,200	60
September,	1,167,200	69	569,100	61	92,453,500	117	3,190,100	67	3,019,600	74	451,400	76	3,085,000	59
October,	1,097,200	64	501,000	53	88,919,000	112	3,214,300	67	2,916,300	71	382,200	64	2,944,200	56
November,	999,000	58	523,400	55	86,947,300	109	3,153,600	66	2,790,900	68	375,000	63	2,784,200	53
December,	1,022,400	60	531,800	56	90,611,800	114	3,218,600	67	2,872,200	70	356,900	60	2,686,000	51
For the year,	1,290,300	76	577,700	62	94,634,000	120	3,501,200	74	3,365,800	83	494,600	84	3,254,700	62

TABLE NO. 24. — *Average Daily Consumption of Water in Cities and Towns, etc.* — Continued.

City or town,	Medford.		Melrose.		Milton.		Nahant.		Quincy.		Revere.	
Population,	34,600.		17,870.		9,250.		1,530.		44,200.		29,350.	
	Gallons.		Gallons.		Gallons.		Gallons.		Gallons.		Gallons.	
Month.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.
January,	2,027,900	60	1,237,500	70	425,100	46	142,200	94	3,862,000	88	2,393,500	83
February,	3,127,000	92	1,918,600	108	557,900	61	183,900	122	4,554,700	104	2,912,100	101
March,	2,762,100	81	1,424,400	80	541,700	59	209,500	138	4,945,100	113	2,171,300	75
April,	2,240,300	65	1,110,800	62	449,300	49	135,100	89	4,451,000	101	1,728,500	60
May,	2,162,000	63	1,198,400	67	471,100	51	216,200	142	4,440,000	101	1,863,000	64
June,	2,324,900	67	1,164,600	65	513,000	56	360,400	236	4,471,700	101	1,925,400	66
July,	2,194,400	63	1,083,400	61	425,400	46	398,900	261	4,665,100	106	2,068,300	70
August,	2,141,900	62	1,060,500	59	363,200	39	422,900	276	4,838,800	109	2,162,600	73
September,	1,882,500	54	1,035,900	58	360,500	39	288,700	187	4,588,200	103	1,793,400	61
October,	1,814,700	52	991,600	55	379,500	41	191,600	124	4,690,600	106	1,614,900	54
November,	1,693,400	48	1,004,600	56	374,400	40	104,900	68	5,015,700	113	1,548,900	52
December,	1,640,500	47	995,200	55	364,100	39	79,400	51	5,054,200	113	1,585,200	53
For the year,	2,161,200	62	1,180,600	66	434,500	47	228,200	149	4,632,100	105	1,975,500	67

TABLE NO. 24. — *Average Daily Consumption of Water in Cities and Towns, etc.* — Concluded.

City or town,	Somerville.		Stoneham.		Swampscott.		Watertown.		Winthrop.		Metropolitan District.	
Population,	92,930.		7,760.		7,900.		18,520.		14,600.		1,241,460.	
	Gallons.		Gallons.		Gallons.		Gallons.		Gallons.		Gallons.	
Month.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.
January,	8,870,200	96	675,400	87	498,800	63	1,971,100	108	778,600	54	144,527,200	118
February,	9,530,000	103	1,166,500	151	685,300	87	2,506,900	137	1,372,700	96	159,833,000	130
March,	8,215,000	89	989,700	128	579,300	73	2,307,800	126	1,182,400	82	137,041,700	111
April,	7,414,800	80	778,900	101	698,500	88	1,987,200	108	983,000	68	123,885,900	100
May,	7,398,300	80	558,900	72	581,700	73	2,339,700	127	971,000	67	125,179,700	101
June,	7,554,900	81	508,200	66	691,800	87	2,410,600	131	961,200	66	127,433,500	103
July,	7,156,100	77	507,100	65	700,000	88	2,564,600	138	1,073,300	74	127,576,600	103
August,	6,832,200	73	474,400	61	726,500	91	2,730,300	147	1,055,700	72	128,274,500	103
September,	6,633,300	71	446,900	58	608,800	76	2,550,500	137	828,700	56	124,953,300	100
October,	6,572,600	70	439,200	56	566,600	71	2,447,800	131	719,700	49	120,403,000	96
November,	6,679,800	71	457,600	59	510,600	64	2,886,900	154	718,900	49	118,569,100	95
December,	6,497,800	69	453,400	58	435,200	54	2,523,600	134	691,000	47	121,619,300	97
For the year,	7,433,200	80	617,700	80	606,100	76	2,434,700	131	941,900	65	129,764,000	105

TABLE NO. 25. — *Consumption of Water in the Metropolitan Water District, as constituted in the Year 1918, and a Small Section of the Town of Saugus, from 1893 to 1918.*

[Gallons per Day.]

MONTH.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.
January,	75,209,000	67,506,000	68,925,000	82,946,000	85,366,000	83,880,000	96,442,000	100,055,000	111,275,000
February,	71,900,000	68,944,000	80,375,000	87,021,000	83,967,000	87,475,000	103,454,000	98,945,000	117,497,000
March,	67,638,000	62,710,000	69,543,000	86,111,000	82,751,000	85,468,000	90,200,000	97,753,000	105,509,000
April,	62,309,000	57,715,000	62,909,000	77,529,000	79,914,000	76,574,000	86,491,000	89,497,000	93,317,000
May,	61,025,000	60,676,000	65,194,000	73,402,000	76,772,000	76,677,000	89,448,000	87,780,000	95,567,000
June,	63,374,000	68,329,000	69,905,000	77,639,000	77,952,000	83,463,000	97,691,000	98,581,000	103,420,000
July,	69,343,000	73,642,000	69,667,000	80,000,000	85,525,000	88,228,000	96,821,000	107,786,000	106,905,000
August,	66,983,000	67,995,000	72,233,000	78,537,000	84,103,000	87,558,000	92,072,000	102,717,000	102,815,000
September,	64,654,000	67,137,000	73,724,000	74,160,000	84,296,000	88,296,000	91,478,000	103,612,000	102,103,000
October,	63,770,000	62,735,000	67,028,000	71,762,000	79,551,000	81,770,000	89,580,000	98,358,000	103,389,000
November,	61,204,000	62,231,000	64,881,000	71,933,000	72,762,000	78,177,000	86,719,000	93,648,000	101,324,000
December,	66,700,000	65,108,000	70,443,000	79,449,000	76,594,000	86,355,000	85,840,000	97,844,000	113,268,000
Average,	66,165,000	65,382,000	69,499,000	78,360,000	80,798,000	83,651,000	92,111,000	98,059,000	104,645,000
Population,	724,180	744,720	765,430	787,880	810,340	832,790	855,250	877,700	892,740
Per capita,	91.4	87.8	90.8	99.5	99.7	100.4	107.7	111.7	117.2

See note at end of this table.

TABLE No. 25. — *Consumption of Water, etc.* — Continued.

[Gallons per Day.]

MONTH.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.
January,	118,435,000	125,176,000	137,771,000	130,878,000	126,093,000	137,730,000	132,376,000	133,275,000	127,568,000
February,	117,268,000	122,728,000	143,222,000	140,595,000	130,766,000	150,822,000	146,199,000	130,763,000	131,093,000
March,	108,461,000	111,977,000	123,334,000	120,879,000	123,570,000	134,202,000	128,884,000	126,842,000	117,078,000
April,	103,153,000	107,179,000	108,688,000	111,898,000	118,428,000	121,556,000	128,926,000	125,335,000	112,775,000
May,	106,692,000	111,589,000	111,715,000	115,804,000	122,404,000	123,502,000	131,040,000	123,305,000	112,073,000
June,	110,002,000	105,590,000	111,209,000	117,441,000	121,882,000	125,623,000	139,843,000	125,179,000	114,082,000
July,	108,340,000	107,562,000	113,584,000	124,769,000	118,726,000	128,779,000	138,232,000	126,765,000	122,743,000
August,	107,045,000	103,570,000	112,836,000	121,158,000	120,591,000	131,098,000	128,073,000	121,781,000	118,373,000
September,	107,752,000	106,772,000	114,188,000	120,103,000	121,685,000	124,751,000	129,972,000	118,043,000	112,434,000
October,	106,560,000	103,602,000	108,290,000	118,301,000	116,561,000	124,051,000	124,189,000	115,939,000	112,332,000
November,	105,175,000	103,477,000	108,054,000	116,693,000	113,746,000	119,627,000	117,119,000	111,664,000	107,528,000
December,	125,434,000	114,721,000	125,119,000	122,696,000	130,995,000	122,407,000	124,468,000	115,733,000	121,994,000
Average,	110,345,000	110,277,000	118,114,000	121,671,000	122,085,000	128,561,000	130,712,000	122,851,000	117,458,000
Population,	907,780	922,820	937,860	955,920	981,720	1,007,520	1,025,890	1,051,420	1,077,090
Per capita,	121.6	119.5	125.9	127.3	124.4	127.6	127.4	116.8	109.1

See note at end of this table.

TABLE NO. 25. — *Consumption of Water, etc.* — Concluded.

[Gallons per day.]

MONTH.	1911.	1912.	1913.	1914.	1915.	1916.	1917.	1918.
January,	123,281,000	137,277,000	113,489,000	117,387,000	109,689,000	110,202,000	115,416,000	146,582,000
February,	124,359,000	141,440,000	120,713,000	127,083,000	108,361,000	112,338,000	120,840,000	156,628,000
March,	116,669,000	122,804,000	107,871,000	110,106,000	102,241,000	109,944,000	109,068,000	140,078,000
April,	111,656,000	113,308,000	104,086,000	103,609,000	98,085,000	100,326,000	102,817,000	125,975,000
May,	118,095,000	114,548,000	104,311,000	105,821,000	98,940,000	103,940,000	102,883,000	126,139,000
June,	114,145,000	118,793,000	108,193,000	114,165,000	104,252,000	103,349,000	106,043,000	128,152,000
July,	123,052,000	120,261,000	112,084,000	106,233,000	101,074,000	106,392,000	113,344,000	127,289,000
August,	111,091,000	112,968,000	106,660,000	105,786,000	101,331,000	110,090,000	114,870,000	128,642,000
September,	108,726,000	112,352,000	105,449,000	109,873,000	108,043,000	108,691,000	109,467,000	125,352,000
October,	106,873,000	110,220,000	103,756,000	105,241,000	103,622,000	108,008,000	107,104,000	121,798,000
November,	105,373,000	109,289,000	101,441,000	101,228,000	101,474,000	103,835,000	103,892,000	119,242,000
December,	104,592,000	110,114,000	102,480,000	108,741,000	102,074,000	106,777,000	120,326,000	122,502,000
Average,	113,951,000	118,546,000	107,466,000	109,489,000	103,227,000	106,994,000	110,475,000	130,551,000
Population,	1,103,290	1,129,500	1,155,710	1,181,920	1,208,160	1,234,460	1,260,760	1,287,050
Per capita,	103.3	105.0	93.0	92.6	85.4	86.7	87.6	101.4

This table includes the water consumed in the cities and towns enumerated in Table No. 24, together with the water consumed in Newton, which is included in the Metropolitan Water District but has not been supplied from the Metropolitan Works, and a small section of the town of Saugus.

From 1893 to 1903, inclusive, consumption based on pumpage. Since 1903, portion of supply delivered by gravity and measured by meters.

Table No. 26. — *Chemical Examinations of Water from the Wachusett Reservoir, Clinton.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Odor.		Residue on Evaporation.		Ammonia.				Chlorine.	Hardness.
		Turbidity.	Sediment.	Color. Platinum Standard	Cold.	Hot.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		
139974	Jan. 1	None.	V. slight.	.15	V. faintly vegetable.		3.65	1.60	.0014	.0116	.0100	.0016	.27	1.1
140027	Jan. 8	V. slight.	V. slight.	.12	V. faintly vegetable.		3.00	1.50	.0020	.0090	.0078	.0012	.29	1.0
140160	Jan. 22	None.	V. slight.	.11	V. faintly vegetable.		3.55	1.35	.0046	.0120	.0096	.0024	.29	1.1
140318	Feb. 5	None.	V. slight.	.12	V. faintly vegetable.		3.35	1.10	.0020	.0120	.0096	.0024	.31	1.1
140583	Feb. 26	V. slight.	None.	.15	V. faintly vegetable.		4.20	1.20	.0026	.0090	.0088	.0002	.28	1.1
140721	Mar. 12	V. slight.	V. slight.	.24	V. faintly vegetable.		3.55	1.75	.0038	.0144	.0128	.0016	.27	1.0
140928	Mar. 26	V. slight.	V. slight.	.20	V. faintly vegetable.		3.10	1.00	.0020	.0100	.0094	.0006	.30	1.3
141069	Apr. 9	V. slight.	V. slight.	.12			3.95	1.50	.0020	.0152	.0142	.0010	.28	1.0
141373	May 14	V. slight.	V. slight.	.15			3.30	1.05	.0014	.0136	.0116	.0020	.27	1.0
141482	May 21	None.	V. slight.	.16			3.20	1.05	.0018	.0118	.0102	.0016	.28	1.0
141679	June 4	V. slight.	V. slight.	.14			3.30	1.10	.0024	.0132	.0122	.0010	.28	1.3
141968	June 18	V. slight.	V. slight.	.15			3.70	1.25	.0068	.0146	.0130	.0016	.28	1.3
142342	July 16	V. slight.	V. slight.	.16			3.45	1.30	.0020	.0162	.0140	.0022	.32	1.1
142524	July 24	V. slight.	None.	.15			3.45	1.30	.0020	.0136	.0120	.0016	.27	1.1
142744	Aug. 6	V. slight.	V. slight.	.15	sweetish.	nd sweet-	1.95	0.80	.0030	.0162	.0140	.0022	.26	1.0
143037	Aug. 20	V. slight.	V. slight.	.14	V. faintly vegetable.		3.60	1.00	.0012	.0120	.0110	.0010	.30	1.1
143294	Sept. 10	V. slight.	V. slight.	.13	V. faintly vegetable.		2.45	1.10	.0014	.0166	.0146	.0020	.36	1.3
143577	Sept. 25	None.	V. slight.	.13	V. faintly vegetable.		2.70	1.00	.0028	.0120	.0092	.0028	.32	1.7
143694	Oct. 8	None.	V. slight.	.15	V. faintly vegetable and cucumber.	cucum-	2.90	1.20	.0026	.0130	.0094	.0006	.26	1.0
143960	Oct. 29	V. slight.	None.	.12	V. faintly vegetable.		3.05	1.00	.0022	.0094	.0090	.0004	.29	1.3
144245	Nov. 19	V. slight.	V. slight.	.12	V. faintly vegetable.		3.00	0.80	.0024	.0070	.0064	.0006	.34	1.1
144434	Dec. 10	V. slight.	V. slight.	.11	V. faintly vegetable.		3.35	1.00	.0028	.0194	.0182	.0012	.38	1.0
144703	Dec. 23	V. slight.	V. slight.	.11	V. faintly vegetable.		3.30	1.26	.0026	.0150	.0138	.0012	.33	1.3
Av.	....	....	....	.16	....	....	3.24	1.17	.0026	.0137	.0113	.0014	.29	1.1

TABLE NO. 27. — *Chemical Examinations of Water from the Sudbury Reservoir.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.		Appearance. Color.	Odor.		Residue on Evaporation.		Ammonia.	Ammonia. Albuminoid.			Chlorine.	Hardness.
		Turbidity.	Sediment.	Platinum Standard.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		
140009	Jan. 7	None.	V. slight.	.14	V. faintly vegetable.	Faintly vegetable.	4.50	1.95	.0010	.0126	.0118	.0008	.32	1.3
140338	Feb. 5	None.	V. slight.	.17	V. faintly vegetable.	Faintly vegetable.	3.70	1.00	.0026	.0120	.0100	.0020	.30	1.3
140637	Mar. 5	V. slight.	V. slight.	.18	V. faintly vegetable.	Faintly vegetable.	3.75	1.70	.0052	.0142	.0124	.0018	.36	1.0
141007	Apr. 1	V. slight.	V. slight.	.24	Faintly vegetable.	Faintly vegetable.	3.75	1.80	.0076	.0180	.0140	.0040	.32	1.1
141250	May 6	V. slight.	Slight.	.25	V. faintly vegetable.	Faintly vegetable.	3.50	1.05	.0018	.0158	.0134	.0024	.32	1.0
141350	May 10	V. slight.	V. slight.	.20	Faintly vegetable.	Distinctly vegetable.	3.25	1.35	.0026	.0168	.0144	.0024	.32	1.0
141664	June 3	V. slight.	V. slight.	.20	Faintly vegetable.	Distinctly vegetable.	4.10	1.75	.0012	.0172	.0132	.0040	.33	1.4
142208	July 9	V. slight.	V. slight.	.16	V. faintly vegetable.	Faintly vegetable.	3.15	1.20	.0024	.0186	.0150	.0036	.32	1.4
142791	Aug. 9	V. slight.	V. slight.	.11	V. faintly vegetable.	V. faintly vegetable.	4.05	2.00	.0050	.0172	.0152	.0020	.29	1.3
143198	Sept. 4	V. slight.	None.	.17	Faintly vegetable and unpleasant.	Distinctly vegetable and unpleasant.	3.20	1.15	.0022	.0112	.0100	.0012	.32	1.3
143681	Oct. 7	V. slight.	V. slight.	.12	V. faintly vegetable.	V. faintly vegetable.	3.55	1.00	.0050	.0098	.0060	.0038	.32	1.3
144045	Nov. 5	V. slight.	V. slight.	.15	V. faintly vegetable.	V. faintly vegetable.	3.50	1.00	.0032	.0106	.0090	.0016	.32	1.6
144570	Dec. 16	V. slight.	V. slight.	.21	V. faintly vegetable.	Faintly vegetable.	3.60	1.40	.0034	.0148	.0140	.0008	.39	1.4
Av.	....	....	....	.17	....	....	3.66	1.41	.0033	.0145	.0121	.0023	.32	1.2

TABLE NO. 28. — *Chemical Examinations of Water from Spot Pond, Stoneham.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.		Color.	Odor.		Residue on Evaporation.		Ammonia.				Chlorine.	Hardness.
		Turbidity.	Sediment.	Platinum Standard.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		
140135	Jan. 21	None.	V. slight.	.10	V. faintly unpleasant and fishy.	Faintly unpleasant and fishy.	4.50	1.70	.0024	.0172	.0130	.0042	.36	1.4
140348	Feb. 11	V. slight.	None.	.15	V. faintly vegetable.	V. faintly vegetable.	3.60	1.20	.0046	.0162	.0128	.0034	.35	1.4
140619	Mar. 1	None.	None.	.14	V. faintly vegetable.	Faintly vegetable.	3.50	1.45	.0020	.0156	.0128	.0028	.35	1.6
140988	Apr. 1	V. slight.	V. slight.	.15	Faintly vegetable and unpleasant.	Faintly vegetable and unpleasant.	4.00	1.30	.0006	.0164	.0128	.0036	.36	1.3
141353	May 13	V. slight.	Slight.	.21	Faintly unpleasant and fishy.	Distinctly unpleasant and fishy.	3.60	1.00	.0004	.0176	.0140	.0036	.28	1.3
141789	June 10	V. slight.	V. slight.	.10	Faintly vegetable and earthy.	Distinctly vegetable and earthy.	3.45	1.15	.0018	.0244	.0180	.0064	.32	1.0
142310	July 15	None.	V. slight.	.10	V. faintly vegetable and unpleasant.	Faintly vegetable and unpleasant.	3.50	1.25	.0008	.0162	.0146	.0016	.36	1.4
142960	Aug. 19	V. slight.	V. slight.	.12	V. faintly vegetable.	Faintly vegetable.	3.60	1.35	.0016	.0158	.0120	.0038	.39	1.3
143315	Sept. 10	None.	V. slight.	.10	V. faintly vegetable.	Faintly vegetable.	3.20	1.00	.0024	.0140	.0122	.0018	.37	1.3
144005	Nov. 4	V. slight.	V. slight.	.10	Faintly vegetable.	Distinctly vegetable.	3.70	1.20	.0022	.0176	.0170	.0006	.42	1.6
144563	Dec. 16	V. slight.	V. slight.	.11	V. faintly vegetable.	Faintly vegetable.	3.80	1.65	.0032	.0182	.0166	.0016	.38	1.3
Av.	....	....	....	.12	....	....	3.67	1.29	.0020	.0172	.0141	.0030	.35	1.3

TABLE NO. 29. — *Chemical Examinations of Water from Lake Cochituate.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.		Color.	Odor.		Residue on Evaporation.		Ammonia.				Chlorine.	Hardness.
		Turbidity.	Sediment.	Platinum Standard.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		
139992	Jan. 7	V. slight.	V. slight.	.17	V. faintly vegetable.	Faintly vegetable.	6.25	2.10	.0060	.0230	.0188	.0042	.76	3.0
140307	Feb. 4	V. slight.	V. slight.	.20	V. faintly vegetable and earthy.	Faintly vegetable and earthy.	7.15	3.45	.0054	.0234	.0160	.0074	.76	2.6
140635	Mar. 5	V. slight.	V. slight.	.28	V. faintly vegetable.	Faintly vegetable.	6.30	3.00	.0046	.0264	.0166	.0098	.74	2.3
141004	Apr. 1	V. slight.	V. slight.	.26	Faintly vegetable.	Distinctly vegetable.	6.85	3.35	.0024	.0302	.0194	.0108	.63	2.0
141257	May 6	Slight.	Slight.	.25	Faintly vegetable.	Distinctly vegetable.	6.00	2.50	.0010	.0308	.0164	.0144	.68	3.0
141661	June 3	Slight.	Slight.	.18	Distinctly vegetable and earthy.	Decidedly vegetable and earthy.	6.15	1.55	.0008	.0296	.0194	.0102	.74	2.1
142204	July 9	V. slight.	V. slight.	.18	Faintly vegetable and unpleasant.	Faintly vegetable and unpleasant.	5.70	1.55	.0012	.0288	.0238	.0050	.76	2.6
142715	Aug. 6	V. slight.	V. slight.	.18	Faintly vegetable.	Faintly vegetable.	7.20	2.05	.0022	.0264	.0242	.0022	.68	2.3
143202	Sept. 4	V. slight.	None.	.12	Faintly vegetable and earthy.	Distinctly vegetable and earthy.	6.30	2.20	.0022	.0194	.0178	.0016	.76	2.6
143667	Oct. 3	Slight.	Slight.	.15	Faintly vegetable and earthy.	Distinctly vegetable and earthy.	5.90	1.65	.0008	.0254	.0178	.0076	.80	2.5
144042	Nov. 4	Slight.	V. slight.	.20	Faintly vegetable and earthy.	Distinctly vegetable and earthy.	6.45	1.50	.0008	.0270	.0196	.0074	.74	2.2
144542	Dec. 12	Slight.	V. slight.	.25	Faintly unpleasant and earthy.	Distinctly unpleasant and earthy.	5.85	2.50	.0088	.0254	.0192	.0062	.78	2.6
Av.	....	....	....	.20	....	....	6.34	2.28	.0030	.0263	.0190	.0072	.73	2.4

TABLE NO. 30. — *Chemical Examinations of Water from a Tap at the State House, Boston.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Odor.		Residue on Evaporation.		Ammonia.				Chlorine.	Hardness.
		Turbidity.	Sediment.	Color. Platinum Standard.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		
140000	Jan. 9	V. slight.	V. slight.	.19	V. faintly fishy.	Faintly fishy.	3.55	1.80	.0012	.0158	.0118	.0040	.35	1.4
140404	Feb. 13	V. slight.	V. slight.	.12	Faintly vegetable.	Faintly vegetable.	4.50	1.45	.0016	.0120	.0094	.0026	.35	1.7
140614	Mar. 4	V. slight.	V. slight.	.20	V. faintly vegetable and unpleasant.	Faintly vegetable and unpleasant.	3.80	1.00	.0024	.0132	.0122	.0010	.30	1.3
140989	Apr. 1	V. slight.	V. slight.	.22	V. faintly vegetable.	Faintly vegetable.	4.75	2.00	.0036	.0152	.0134	.0018	.36	1.6
141354	May 13	V. slight.	Slight.	.21	Faintly unpleasant and fishy.	Distinctly unpleasant and fishy.	3.60	1.20	.0014	.0228	.0172	.0056	.34	1.6
141650	June 3	Slight.	V. slight.	.20	Faintly vegetable and unpleasant.	Distinctly vegetable and unpleasant.	3.80	1.35	.0012	.0174	.0126	.0048	.32	1.6
142717	Aug. 7	V. slight.	V. slight.	.20	V. faintly vegetable.	Faintly vegetable.	4.20	1.30	.0026	.0142	.0136	.0006	.30	1.6
143150	Sept. 3	V. slight.	V. slight.	.11	V. faintly vegetable.	Faintly vegetable.	3.30	1.25	.0018	.0178	.0132	.0046	.30	1.3
143737	Oct. 16	V. slight.	V. slight.	.22	V. faintly vegetable.	Faintly vegetable.	3.40	1.55	.0008	.0124	.0120	.0004	.32	1.3
144669	Dec. 23	V. slight.	V. slight.	.21	V. faintly vegetable.	V. faintly vegetable.	4.00	1.60	.0024	.0136	.0126	.0010	.32	1.4
Av.	....	....	....	.18	....	....	3.89	1.45	.0019	.0154	.0128	.0026	.29	1.4

TABLE No. 31. — *Averages of Chemical Examinations of Water from Various Parts of the Metropolitan Water Works in 1918.*

[Parts per 100,000.]

Locality.	Samples collected.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Hardness.
		Platinum Standard.	Total.	Loss on Ignition.	Free.	Albuminoid.				
						Total.	Dissolved.	Suspended.		
	Semi-monthly,	.47	4.78	1.89	.0033	.0196	.0161	.0030	.49	1.0
	Semi-monthly,	.32	3.77	1 37	.0029	.0189	.0122	.0018	.24	1.0
,[1]	Semi-monthly,	.27	4.18	1.56	.0026	.0147	.0118	.0022	.33	1.3
se,[3]	Semi-monthly,	.18	3 24	1.17	.0025	0127	.0113	.0014	.29	1.1
m,	Semi-monthly,	.15	3.28	1.27	.0026	.0103	.0095	.0006	.29	1.1
	Monthly,	.58	18.37	5.46	.0789	0382	.0296	.0083	2.97	6.5
nt,[4]	Monthly,	.10	14.87	–	.0043	.0106	–	–	2.15	5.0
,	Monthly,	.16	3.52	1.39	.0031	.0131	.0116	.0014	.31	1.2
	Monthly,	.17	3.66	1.41	.0033	.0145	.0121	.0023	.32	1.3
	Monthly,	.18	3 42	1 25	.0049	.0140	.0124	0016	.32	1.2
	Monthly,	.26	3.94	1.56	.0038	.0164	.0143	.0021	.32	1.4
dam,	Monthly,	18	3.80	1 33	.0031	0163	.0133	.0030	.31	1.3
	Monthly,	.74	5.12	2.02	.0034	.0284	.0244	.0040	.42	1.2
	Monthly,	.53	4.06	1.69	.0037	0215	.0172	.0033	.33	1.2
	Monthly,	.60	4.67	1.86	.0048	.0213	.0175	.0022	.41	1.2
	Monthly,	1 23	6.72	2 69	.0067	.0341	.0302	.0039	.43	1.5
	Monthly,	.61	4.27	1.80	.0036	.0236	.0211	.0025	.37	1.3
	Monthly,	.57	4.43	1.87	.0039	.0228	.0187	.0042	.36	1.2
	Monthly,	.76	5.55	2 12	.0535	.0282	.0247	.0035	.47	1.4
dam,	Monthly,	.70	5.03	2.19	.0039	.0266	.0232	.0034	.44	1.5
	Monthly,	.20	6.34	2.22	0030	.0262	.0190	.0072	.73	2.4
	Monthly,	46	6.89	2.59	0010	.0290	.0201	.0089	.72	2.6
	Monthly,	.18	3.49	1.30	.0029	.0164	.0128	.0036	.33	1.4
uct,	Monthly,	.15	3.67	1.26	0022	.0244	.0123	.0021	.33	1.4
	Monthly,	.12	3.57	1.29	.0020	.0172	.0141	.0030	.35	1.3
	Monthly,	.10	3.70	1.29	.0014	.0132	0097	.0015	.33	1.4
	Monthly,	.18	3.89	1.45	.0019	.0154	.0128	.0026	.29	1.4
Tap in Quincy,	Monthly,	.16	3 69	1.30	.0015	.0119	0098	.0009	.33	1.4

[1] Averages of 22 samples.
[2] Averages of 21 samples.
[3] Averages of 23 samples.
[4] Averages of 6 samples.
[5] Averages of 11 samples.
[6] Averages of 10 samples.

TABLE No. 32. — *Chemical Examinations of Water from a Faucet in Boston, from 1892 to 1918.*

[Parts per 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Oxygen consumed.	Hardness.
					Albuminoid.					
	Platinum Standard.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.			
1892, ...	.37	4.70	1.67	.0007	.0168	.0138	.0030	.41	-	1.9
1893, ...	.53	4.54	1.84	.0010	.0174	.0147	.0027	.38	.60	1.8
1894, ...	.58	4.64	1.83	.0006	.0169	.0150	.0019	.41	.63	1.7
1895, ...	.59	4.90	2.02	.0006	.0197	.0175	.0023	.40	.69	0.7
1896, ...	.45	4.29	1.67	.0005	.0165	.0142	.0023	.37	.56	1.4
1897, ...	.55	4.82	1.84	.0009	.0193	.0177	.0016	.40	.64	1.6
1898, ...	.40	4.19	1.60	.0008	.0152	.0136	.0016	.39	.44	1.4
1899, ...	.28	3.70	1.30	.0006	.0136	.0122	.0014	.24	.35	1.1
1900, ...	.29	3.80	1.20	.0012	.0157	.0139	.0018	.25	.38	1.3
1901, ...	.29	4.43	1.64	.0013	.0158	.0142	.0016	.39	.43	1.7
1902, ...	.30	3.93	1.56	.0016	.0139	.0119	.0020	.29	.40	1.3
1903, ...	.29	3.98	1.50	.0013	.0125	.0110	.0015	.30	.39	1.5
1904, ...	.23	3.93	1.59	.0023	.0139	.0121	.0018	.34	.37	1.5
1905, ...	.24	3.86	1.59	.0020	.0145	.0124	.0021	.35	.35	1.4
1906, ...	.24	3.86	1.39	.0018	.0159	.0134	.0025	.34	.36	1.3
1907, ...	.22	3.83	1.40	.0013	.0129	.0109	.0020	.33	.32	1.3
1908, ...	.19	3.50	1.35	.0011	.0115	.0092	.0024	.33	.26	1.2
1909, ...	.18	3.46	1.43	.0011	.0128	.0103	.0025	.28	.25	1.3
1910, ...	.14	3.05	1.24	.0013	.0118	.0102	.0016	.28	.22	1.1
1911, ...	.25	4.18	1.66	.0015	.0156	.0128	.0029	.38	.33	1.4
1912, ...	.17	3.36	1.23	.0013	.0154	.0119	.0034	.36	.29	1.7
1913, ...	.13	3.96	1.15	.0014	.0150	.0120	.0026	.35	.26	1.5
1914, ...	.14	4.12	1.19	.0014	.0138	.0116	.0022	.39	.25	1.4
1915, ...	.16	3.73	1.04	.0015	.0157	.0134	.0023	.38	.25	1.4
1916, ...	.18	4.53	1.85	.0013	.0133	.0107	.0026	.36	-	1.4
1917, ...	.15	4.45	1.68	.0015	.0142	.0124	.0018	.33	-	1.3
1918, ...	.18	3.89	1.45	.0019	.0154	.0128	.0026	.29	-	1.4

TABLE No. 33. — *Microscopic Organisms in Water from Various Parts of the Metropolitan Water Works, from 1898 to 1918, inclusive.*

[Standard units per cubic centimeter; averages from weekly or biweekly observations.]

Year.	Wachusett Reservoir.		Sudbury Reservoir.		Lake Cochituate.		Framingham Reservoir No. 3.	Framingham Reservoir No. 2.	Ashland Reservoir.	Hopkinton Reservoir.	Whitehall Reservoir.
	Surface.	Bottom.	Surface.	Bottom.	Surface.	Bottom.	Surface.	Mid-depth.	Surface.	Surface.	Surface.
1898,	-	-	354	149	830	696	390	245	263	944	690
1899,	-	-	470	252	905	644	440	218	357	715	393
1900,	-	-	498	361	1,758	1,071	645	365	390	980	437
1901,	-	-	337	225	992	702	336	149	244	450	705
1902,	-	-	590	402	1,071	730	627	204	550	588	198
1903,	-	-	549	388	931	795	459	169	323	231	327
1904,	313	-	517	376	663	542	475	174	153	106	375
1905,	769	592	644	502	1,255	508	535	158	289	240	147
1906,	446	272	953	714	1,407	1,148	692	228	431	475	1,279
1907,	425	212	513	419	1,128	1,200	413	205	378	336	961
1908,	731	466	850	885	1,559	1,241	932	725	699	516	708
1909,	2,151	1,937	2,474	2,513	1,142	1,198	2,372	610	603	294	445
1910,	480	328	464	556	928	1,033	455	436	426	387	154
1911,	649	368	990	988	1,942	2,216	1,140	378	592	457	397
1912,	585	368	939	882	4,632	7,873	888	241	665	516	390
1913,	449	270	553	541	4,964	7,322	560	253	414	298	494
1914,	753	309	735	692	2,036	4,189	532	-	327	325	89
1915,	519	356	1,005	828	1,900	3,213	701	-	450	284	625
1916,	922	550	930	992	2,708	1,949	837	-	425	347	148
1917,	296	240	658	589	1,670	2,216	663	-	-	-	-
1918,	229	132	475	332	3,492	2,800	455	-	-	-	-

See note at end of this table.

TABLE No. 33. — *Microscopic Organisms in Water, etc.* — Concluded.

[Standard units per cubic centimeter; averages from weekly or biweekly observations.]

Year.	Weston Reservoir.	Spot Pond.	Chestnut Hill Reservoir.			Taps.			
			Sudbury Aqueduct.	Cochituate Aqueduct.	Effluent Gate-house.	Southern Low Service.	Southern High Service.	Northern Low Service.	Northern High Service.
	Surface.	Surface.	Inlet.	Inlet.	No. 2.				
1898,	-	485	304	544	304	230	-	-	-
1899,	-	1,129	359	992	329	192	201	-	-
1900,	-	573	568	1,139	897	468	452	-	-
1901,	-	628	344	697	413	243	280	-	-
1902,	-	581	563	937	525	367	451	-	-
1903,	-	650	450	860	435	286	398	-	-
1904,	-	465	405	838	472	303	470	274	189
1905,	-	609	551	904	554	528	671	363	388
1906,	783	671	631	1,042	721	550	583	326	422
1907,	443	590	349	909	419	312	427	205	422
1908,	979	741	783	1,073	689	666	695	443	481
1909,	2,399	1,079	1,999	632	1,899	1,913	1,959	1,313	677
1910,	625	622	457	-	465	447	421	221	374
1911,	934	748	700	1,382	954	778	735	349	461
1912,	1,117	716	855	3,887	919	1,035	967	412	462
1913,	565	607	535	2,622	850	531	410	237	356
1914,	757	648	492	-	540	603	549	249	412
1915,	725	656	643	-	601	597	631	262	419
1916,	857	811	842	-	1,041	872	858	409	520
1917,	570	446	598	638	717	569	534	352	294
1918,	415	347	417	2,766	521	390	485	251	217

NOTE. — A large growth of Asterionella originated in the Wachusett Reservoir in 1909, causing the large number of organisms in the water of Sudbury Reservoir and Framingham Reservoir No. 3, Weston and Chestnut Hill reservoirs, Spot Pond and in the water drawn from taps.

TABLE No. 34. — *Number of Bacteria per Cubic Centimeter in Water from Various Parts of the Metropolitan Water Works, from 1898 to 1918, inclusive.*

[Averages of weekly determinations.]

Year.	Chestnut Hill Reservoir.			Southern Service Taps.	
	Sudbury Aqueduct Terminal Chamber.	Cochituate Aqueduct.	Effluent Gate-house No. 2.	Low Service, 180 Boylston Street.	High Service, 1 Ashburton Place.
1898,	207	145	111	96	-
1899,	224	104	217	117	123
1900,	248	113	256	188	181
1901,	225	149	169	162	168
1902,	203	168	121	164	246
1903,	76	120	96	126	243
1904,	347	172	220	176	355
1905,	495	396	489	231	442
1906,	231	145	246	154	261
1907,	147	246	118	130	176
1908,	162	138	137	136	148
1909,	198	229	119	150	195
1910,	216	-	180	178	213
1911,	205	204	151	175	197
1912,	429	450	227	249	259
1913,	123	243	157	119	140
1914,	288	-	252	174	220
1915,	163	-	128	117	134
1916,	128	-	85	102	105
1917,	178	112	119	119	141
1918,	1,163	168	705	317	544

TABLE No. 35. — *Colors of Water from Various Parts of the Metropolitan Water Works in 1918. (Averages of Weekly Determinations.)*

[Platinum Standard.]

MONTH.	WACHUSETT RESERVOIR.						SUDBURY RESERVOIR.				FRAMINGHAM RESERVOIR No. 3.	LAKE COCHITUATE.			CHESTNUT HILL RESERVOIR.			SPOT POND.	FELLS RESERVOIR.	NORTHERN SERVICE.		SOUTHERN SERVICE.	
	Surface.	Mid-depth.	Bottom.	Worcester Street Bridge.	Quinepoxet River.	Stillwater River.	Surface.	Mid-depth.	Bottom.	End of Open Channel.	Mid-depth.	Surface.	Mid-depth.	Bottom.	Inlet (Sudbury Aqueduct).	Inlet (Cochituate Aqueduct).	Effluent Gate-house No. 2.	Mid-depth.	Effluent Gate-house.	Tap at Glenwood Yard, Medford (Low Service).	Tap at Fire Station, Hancock Street, Everett (High Service).	Tap at 180 Boylston Street, Boston (Low Service).	Tap at 1 Ashburton Place, Boston (High Service).
January,	11	11	12	28	40	19	15	16	15	15	15	16	17	17	15	–	14	9	9	14	9	14	14
February,	9	9	9	32	34	23	12	12	11	13	13	18	15	15	14	16	12	7	5	13	5	12	13
March,	15	18	11	31	33	31	17	15	17	52	17	26	–	–	16	–	14	7	6	14	6	14	14
April,	11	9	12	28	33	28	17	17	17	15	17	18	18	18	17	–	16	9	6	16	6	16	16
May,	11	12	12	32	44	39	16	17	16	15	17	17	18	14	17	–	16	8	7	15	7	17	17
June,	11	12	12	24	47	36	14	15	16	14	15	15	16	46	15	–	14	8	7	14	7	14	15
July,	10	11	12	14	34	34	11	12	12	12	11	13	16	24	12	–	11	6	5	12	5	11	12
August,	9	11	11	13	28	21	10	11	12	10	11	11	17	41	10	–	9	6	6	10	6	10	10
September,	8	9	9	10	38	29	9	–	9	–	10	11	16	62	10	–	9	7	6	11	6	10	11
October,	10	11	11	14	50	31	14	14	15	78	15	13	16	79	13	–	12	9	8	13	8	12	13
November,	12	11	14	25	60	37	14	14	15	13	16	15	15	78	15	–	14	10	8	15	9	15	15
December,	10	10	11	43	47	31	15	15	15	13	15	16	16	16	15	–	14	8	8	14	8	14	14
Averages,	11	11	11	25	41	30	14	14	14	23	14	16	16	37	14	16	13	8	7	13	7	13	14

TABLE NO. 36. — *Temperatures of Water from Various Parts of the Metropolitan Water Works in 1918. (Averages of Weekly Determinations.)*

[The temperatures are taken at the same places and times as the samples for microscopical examination; the depth given for each reservoir is the depth from high-water mark.]

[Degrees Fahrenheit.]

MONTH.	WACHUSETT[1] RESERVOIR (DEPTH AT PLACE OF OBSERVATION 107 FEET). Surface.	Mid-depth.	Bottom.	SUDBURY[1] RESERVOIR (DEPTH AT PLACE OF OBSERVATION 54.5 FEET). Surface.	Mid-depth.	Bottom.	WACHUSETT AQUEDUCT. End of Open Channel.	FRAMINGHAM[1] RESERVOIR NO. 3 (DEPTH AT PLACE OF OBSERVATION 20.5 FEET). Surface.	Mid-depth.	Bottom.	LAKE COCHITUATE[1] (DEPTH AT PLACE OF OBSERVATION 62.0 FEET). Surface.	Mid-depth.	Bottom.	CHESTNUT HILL RESERVOIR. Effluent Gate-house No. 2.	SPOT POND[1] (DEPTH AT PLACE OF OBSERVATION 28.0 FEET). Surface.	Mid-depth.	Bottom.	NORTHERN SERVICE. Tap at Glenwood Yard, Medford (Low Service).	Tap at Fire Station, Hancock Street, Everett (High Service).	SOUTHERN SERVICE. Tap at 180 Boylston Street, Boston (Low Service).	Tap at 1 Ashburton Place, Boston (High Service).
January,	34.4	34.7	37.5	32.9	35.5	36.0	33.8	34.3	34.9	34.4	35.3	36.7	37.0	35.4	35.3	36.5	36.0	37.2	37.2	37.5	41.4
February,	35.8	36.5	36.7	34.2	35.3	36.5	34.0	34.3	33.9	35.4	35.4	35.9	35.9	35.1	36.0	35.9	37.8	36.3	38.0	36.2	38.4
March,	35.8	36.3	37.3	35.8	36.0	37.0	35.3	36.5	36.6	35.2	36.9	–	–	35.7	37.1	38.0	38.0	36.7	38.7	37.7	38.6
April,	40.8	41.1	39.3	44.4	44.0	43.0	41.5	52.8	52.6	–	44.6	43.2	41.6	44.4	43.9	45.5	44.1	44.0	45.0	45.0	46.2
May,	58.9	56.0	49.3	62.6	63.0	58.5	58.5	64.5	64.5	60.6	63.4	47.4	45.5	61.7	60.7	62.3	56.3	59.0	62.7	61.8	62.7
June,	64.4	60.0	50.3	67.9	65.0	61.5	54.0	67.3	66.5	65.9	67.7	48.7	45.7	67.5	67.3	66.4	63.5	65.5	66.5	67.4	67.8
July,	71.3	60.0	53.5	73.5	66.8	64.8	57.0	73.7	71.3	69.2	55.0	49.1	46.6	71.0	72.1	69.8	68.2	68.6	69.3	70.7	71.3
August,	73.0	56.8	50.5	73.6	70.8	68.3	59.5	72.9	72.7	72.5	73.4	50.1	46.7	72.9	73.2	72.5	70.5	71.8	71.8	73.3	73.5
September,	67.3	65.3	53.8	67.5	68.3	66.0	65.5	66.5	65.5	–	66.6	51.0	47.9	67.8	67.3	68.0	66.5	69.0	68.0	68.7	69.7
October,	57.5	57.5	53.2	57.4	57.6	57.3	55.5	56.5	56.4	54.9	57.2	44.0	46.5	57.5	57.1	56.9	57.5	59.8	59.2	58.7	59.7
November,	50.9	52.5	49.3	49.8	50.0	51.5	44.6	47.5	44.7	51.0	49.7	49.6	46.0	50.5	49.9	48.8	52.0	54.7	51.5	51.5	53.1
December,	40.4	40.0	40.5	35.6	36.3	38.7	35.3	36.3	36.0	36.9	38.6	39.1	40.3	37.5	37.1	37.0	38.1	42.0	39.4	40.8	41.8
Averages,	52.6	49.7	45.9	52.9	52.4	51.6	47.9	53.6	53.0	51.6	52.0	45.0	43.6	53.1	53.1	53.1	52.4	53.7	53.9	54.1	55.3

[1] Surface temperatures are averages of weekly determinations. Mid-depth and bottom temperatures are averages of biweekly determinations.

TABLE NO. 37. — *Temperatures of the Air at Three Stations on the Metropolitan Water Works in 1918.*

[Degrees Fahrenheit.]

MONTH.	CHESTNUT HILL RESERVOIR.			FRAMINGHAM.			CLINTON.		
	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.
January,	50	—3	22.2	48	—6	18.4	49	—7	16.9
February,	56	—14	29.9	55	—14	24.9	54	—16	23.2
March,	67	–[1]	–[1]	66	1	36.5	63	–	34.9
April,	78	19	44.2	78	27	47.8	72	27	43.6
May,	89	32	60.6	88	37	64.3	86	38	61.9
June,	93	37	62.1	93	37	65.0	86	41	62.0
July,	96	44	68.0	96	50	71.1	92	49	69.4
August,	95	41	68.3	95	44	72.0	93	44	69.6
September,	82	31	57.7	88	37	60.7	78	37	58.5
October,	78	25	53.5	79	29	55.2	77	31	53.5
November,	63	10	39.4	65	15	42.4	64	15	41.9
December,	60	4	29.1	59	10	32.1	57	6	31.5
Averages,	–	–	–	–	–	49.2	–	–	46.8

[1] Minimum thermometer out of order.

TABLE NO. 38. — *Table showing Length of Main Lines of Water Pipes and Connections owned and operated by Metropolitan Water and Sewerage Board, and Number of Valves set in Same, Dec. 31, 1918.*

	Diameter of Pipes in Inches.															Total.
	60	48	42	40	36	30	24	20	16	14	12	10	8	6	4	
Total length owned and operated Dec. 31, 1917 (feet).	43,802	211,092	9,810	6,989	61,787	49,771	85,492	76,059	67,856	26	26,546	3,829	1,878	994	33	645,964
Gate valves in same,	5	56	1	2	55	44	61	55	82	1	109	20	18	23	1	533
Air valves in same,	51	125	5	3	44	21	43	45	34	-	10	1	-	-	-	382
Length laid or relaid during 1918 (feet),	-	-	-	-	6	12	914	9,698	539	-	67	-	-	-	-	11,236
Gate valves in same,	-	-	-	-	-	-	1	4	2	-	2	-	-	-	-	9
Air valves in same,	-	-	-	-	-	-	-	7	1	-	-	-	-	-	-	8
Length abandoned during 1918 (feet),	-	-	-	-	6	12	910	38	28	-	50	-	-	-	-	1,044
Gate valves in same,	-	-	-	-	-	-	1	3	1	-	1	-	-	-	-	6
Air valves in same,	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1
Length owned and operated Dec. 31, 1918 (feet).	43,802[1]	211,092	9,810	6,989	61,787	49,771[2]	85,496	85,719	68,367	26	26,563	3,829	1,878	994	33	656,156[3]
Gate valves in same,	5	56	1	2	55	44	61	56	83	1	110	20	18	23	1	536
Air valves in same,	51	125	5	3	44	21	43	51	35	-	10	1	-	-	-	389

[1] Includes 2,035 feet of 76-inch concrete-lined pressure tunnel; 363 feet of 76-inch mortar-lined and concrete-covered steel pipe; 21 feet of 76-inch cast-iron pipe and 85 feet of 60-inch concrete-covered steel pipe.

[2] Includes 15,512 feet of 30-inch mortar-lined and covered wrought-iron pipe.

[3] 124.27 miles.

TABLE NO. 39. — *Statement of Cast-iron Hydrant, Blow off and Drain Pipes, owned and operated by Metropolitan Water and Sewerage Board, Dec. 31, 1918.*

	DIAMETER OF PIPES IN INCHES.								Total.
	24	20	16	12	10	8	6	4	
Total length in use Dec. 31, 1917 (feet),	352	292	3,121	6,861	176	513	3,515	1,472	16,302
Valves in same,	-	-	30	108	2	9	82	43	274
Length laid or relaid in 1918 (feet),	-	-	-	-	-	-	51	-	51
Valves in same,	-	-	-	-	-	-	3	-	3
Length abandoned in 1918 (feet),	-	-	-	-	-	-	-	-	-
Valves in same,	-	-	-	-	-	-	-	-	-
Total length in use Dec. 31, 1918 (feet),	352	292	3,121	6,861	176	513	3,566	1,472	16,353[1]
Valves in same,	-	-	30	108	2	9	85	43	277

[1] 3.10 miles.

TABLE NO. 40. — *Length of Water Pipes, Four Inches in Diameter and Larger, in the Several Cities and Towns supplied by the Metropolitan Water Works, Dec. 31, 1918.*

BY WHOM OWNED.	INCHES.																	TOTALS.	
	60	48	42	40	36	30	24	20	18	16	14	12	10	8	7	6	4	Feet.	Miles.
Metropolitan Water Works,	43,802	211,092	9,810	6,989	61,787	49,771	85,496	85,719	-	68,367	26	26,563	3,829	1,878	-	994	33	656,156	124.27
Arlington,	-	-	-	-	-	-	-	-	-	-	-	24,136	28,621	40,209	-	145,884	15,611	254,461	48.19
Belmont,	-	-	-	-	-	-	-	-	-	-	-	5,714	16,954	26,557	-	113,212	269	162,706	30.82
Boston,	-	10,607	15,683	16,081	37,236	93,176	79,067	87,071	-	261,199	5,041	1,441,391	386,837	824,094	-	1,235,881	103,356	4,596,720	870.59
Chelsea,	-	-	-	-	-	-	-	-	-	5,176	-	5,479	39,826	30,268	-	143,240	6,656	230,645	43.68
Everett,	-	-	-	-	-	-	2,494	2,900	-	5,204	5,998	6,084	42,804	25,894	-	145,559	30,600	267,527	50.67
Lexington,	-	-	-	-	-	-	-	-	-	-	-	9,000	4,879	35,433	-	120,186	27,209	196,707	37.26
Malden,	-	-	-	-	-	-	-	-	-	6,773	9,179	83,017	31,276	86,594	-	223,552	50,967	491,358	93.06
Medford,	-	-	-	-	-	-	-	673	-	6,775	9,598	32,587	39,447	97,869	-	165,289	26,348	378,586	71.70
Melrose,	-	-	-	-	-	-	-	-	-	5,223	3,024	23,097	20,334	25,720	-	152,347	56,201	285,946	54.16
Milton,	-	-	-	-	-	-	-	-	-	103	44	22,556	20,926	53,687	-	156,114	17,177	270,607	51.25
Nahant,	-	-	-	-	-	-	-	-	-	-	4,000	150	11,550	4,800	-	36,800	59,208	116,508	22.07
Quincy,	-	-	-	-	-	-	-	2,679	-	23,232	-	29,125	44,321	139,931	994	377,066	96,305	713,653	135.16
Revere,[1]	-	-	-	-	-	-	-	-	-	23,813	6,970	24,077	28,037	34,690	-	103,221	71,808	292,619	55.42
Somerville,	-	-	-	-	-	-	-	4,210	367	4,135	7,950	92,254	57,049	108,010	-	214,264	21,990	510,229	96.63
Stoneham,	-	-	-	-	-	-	-	-	-	-	-	7,425	1,825	5,110	-	107,809	18,425	140,594	26.63
Swampscott,	-	-	-	-	-	-	-	-	-	-	3,045	6,714	18,306	6,593	-	84,154	9,025	127,837	24.21
Watertown,	-	-	-	-	-	-	-	-	-	2,991	11,877	5,959	17,464	27,379	-	144,508	11,816	221,994	42.04
Winthrop,	-	-	-	-	-	-	-	-	-	-	-	4,049	24,073	34,652	-	55,025	55,847	173,646	32.89
Total feet,	43,802	221,699	25,493	23,070	99,023	142,947	167,047	183,252	367	412,991	66,752	1,849,377	838,358	1,609,368	994	3,725,108	678,851	10,088,499	-
Total miles,	8.30	41.99	4.83	4.37	18.75	27.07	31.64	34.71	0.07	78.22	12.64	350.26	158.78	304.80	0.19	705.51	128.57	-	1,910.70

[1] Includes small portion of Saugus.

TABLE No. 41. — *Number of Service Pipes, Meters and Fire Hydrants in the Several Cities and Towns supplied by the Metropolitan Water Works, Dec. 31, 1918, and the Number of Services and Meters installed during the Year 1918.*

City or Town.	Services.	Meters.	Fire Hydrants.	Services installed.	Meters installed.
Arlington,	3,171	3,171	502	68	68
Belmont,	1,755	1,755	248	28	28
Boston,	105,458	63,187	9,670	243	318
Chelsea,	5,194	5,184	401	18	19
Everett,	6,043	3,811	586	25	281
Lexington,	1,264	1,264	221	23	23
Malden,	8,192	7,970	610	66	114
Medford,	6,639	6,639	711	58	58
Melrose,	4,199	4,380	380	32	38
Milton,	2,055	2,055	440	29	29
Nahant,	737	557	101	9	9
Quincy,	10,248	9,270	1,207	287	164
Revere,[1]	4,754	3,661	304	47	58
Somerville,	13,514	10,116	1,239	23	121
Stoneham,	1,657	1,649	156	13	13
Swampscott,	1,954	1,954	200	32	32
Watertown,	3,184	3,191	415	52	52
Winthrop,	3,031	2,960	314	15	15
Totals,	183,049	132,774	17,705	1,068	1,450

[1] Includes small portion of Saugus.

TABLE NO. 42. — *Average Elevation of the Hydraulic Grade Line, in Feet, above Boston City Base for Each Month at Stations on Metropolitan Water Works during 1918.*

1918. Month.	Low Service.												Southern High Service.					
	Boston Engine House, Bulfinch Street.		Allston Engine House, Harvard Street.		Medford, Mystic Reservoir.		Somerville Public Library, Highland Avenue.		Malden Water Works Shop, Green Street.		Chelsea Court House.		Boston Metropolitan Water Works Office, 1 Ashburton Place.		Watertown Water Works Office, Main Street.		Belmont Water Works Shop, Waverley Street.	
	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.
January, .	146	138	176	173	163	160	164	161	163	160	161	153	243	228	257	235	254	237
February, .	146	136	180	177	165	162	166	163	163	160	161	152	243	225	246	219	246	222
March, .	154	143	182	179	170	166	-	-	166	162	166	157	246	228	252	224	250	226
April, . .	152	140	181	173	169	164	-	-	166	163	166	158	249	230	257	232	253	232
May, . .	150	138	178	172	168	163	-	-	167	163	167	158	248	229	254	220	252	226
June, . .	150	139	178	172	167	163	-	-	167	163	166	157	245	228	253	212	255	220
July, . .	150	139	181	172	167	161	170	165	167	163	166	156	246	228	249	209	252	217
August, .	151	141	179	172	168	163	167	163	167	162	167	157	245	228	245	206	249	217
September, .	150	142	177	168	167	164	170	165	166	162	165	155	245	228	246	212	251	222
October, .	152	141	178	169	167	162	168	164	166	162	163	154	247	229	250	215	252	224
November, .	154	145	180	170	167	162	168	164	167	162	165	153	247	230	256	238	254	236
December, .	153	143	178	168	167	162	169	164	166	162	164	154	246	228	260	251	256	244
Averages, .	151	140	179	172	167	163	168	164	166	162	165	155	246	228	252	223	252	227

TABLE No. 42. — *Average Elevation of the Hydraulic Grade Line, in feet, above Boston City Base, etc.* — Concluded.

1918. Month.	Southern High Service — Concluded.						Northern High Service.									
	Milton Water Works Office, Adams Street.		Forbes Hill Tower, Quincy.		Quincy Water Works Shop.		Somerville Pumping Station, Cedar Street.		Malden City Hall.		Revere Water Works Office, Broadway.		Lynn Engine House, Union Square.		Winthrop Town Hall, Herman Street.	
	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.
January,	241	231	235	222	232	213	262	241	269	264	257	248	253	241	191	178
February,	239	228	232	218	225	204	259	232	268	264	247	238	239	227	184	171
March,	243	230	233	219	224	202	262	235	269	264	254	241	250	233	183	171
April,	247	234	238	224	232	210	266	241	270	265	259	248	256	240	190	174
May,	245	230	236	221	232	208	266	239	269	263	259	246	254	237	187	174
June,	243	229	234	218	230	205	266	239	269	262	257	241	243	228	187	171
July,	243	228	236	219	230	201	269	244	266	261	253	237	240	214	188	168
August,	242	228	235	219	229	200	268	246	267	263	254	236	244	218	187	170
September,	245	230	233	220	230	204	269	246	268	263	255	243	251	233	190	175
October,	245	231	233	220	230	205	268	246	269	264	260	250	256	244	192	180
November,	243	230	231	218	227	202	269	244	270	264	260	251	258	247	193	178
December,	243	230	230	218	227	204	269	246	270	264	262	253	260	249	194	180
Averages,	243	230	234	220	229	205	266	242	269	263	256	244	250	234	189	174

APPENDIX No. 3.

WATER WORKS STATISTICS FOR THE YEAR 1918.

The Metropolitan Water Works supply the Metropolitan Water District, which includes the following cities and towns: —

City or Town.	Population, Census of 1915.	Estimated Population, July 1, 1918.
Arlington,	14,889	16,910
Belmont,	8,081	9,330
Boston,	745,439	790,330
Chelsea,	43,426	47,570
Everett,	37,718	40,700
Lexington,	5,538	5,900
Malden,	48,907	52,150
Medford,	30,509	34,600
Melrose,	16,880	17,870
Milton,	8,600	9,250
Nahant,	1,387	1,530
Newton,[1]	43,113	45,310
Quincy,	40,674	44,200
Revere,	25,178	29,350
Somerville,	86,854	92,930
Stoneham,	7,489	7,760
Swampscott,	7,345	7,960
Watertown,	16,515	18,520
Winthrop,	12,758	14,600
Total population of Metropolitan Water District,	1,201,300	1,286,770
Saugus,[2]	280	280

[1] No water supplied during the year from Metropolitan Water Works.
[2] Only a small portion of Saugus was supplied with water.

Pumping.

Chestnut Hill Pumping Station No. 1: —

Builders of pumping machinery, Holly Manufacturing Company, Quintard Iron Works and E. P. Allis Company.

Description of coal used: — Bituminous: 65 per cent. Ake Mine, Davenport and miscellaneous. Anthracite: screenings 35 per cent. Price per gross ton in bins: bituminous $5.89 to $12.17, screenings $4.93 to $4.98. Average price per gross ton $7.26. Per cent. ashes 19.

Chestnut Hill Pumping Station No. 2: —

Builders of pumping machinery, Holly Manufacturing Company.

Description of coal used: — Bituminous: 55.8 per cent. Ake Mine, Davenport and miscellaneous. Anthracite: screenings 44.2 per cent. Price per gross ton in bins: bituminous $5.73 to $11.76, screenings $4.60 to $5.41. Average price per gross ton $6.60. Per cent. ashes 24.1.

Spot Pond Station: —

Builders of pumping machinery, Geo. F. Blake Manufacturing Company and Holly Manufacturing Company.

Description of coal used: — Bituminous: 49.4 per cent. Davenport. Anthracite: screenings 50.6 per cent. Price per gross ton in bins: bituminous $8.19 to $11, screenings $5.84 to $6.25. Average price per gross ton $7.44. Per cent. ashes 18.7.

Chestnut Hill Pumping Station No. 1.

	Engines Nos. 1 and 2.	Engine No. 3.	Engine No. 4.	Totals.
Daily pumping capacity (gallons),	16,000,000	20,000,000	30,000,000	66,000,000
Coal consumed for year (pounds),	-	-	-	4,294,757
Cost of pumping, figured on pumping station expenses,	-	-	-	$31,507.94
Total pumpage for year, corrected for slip (million gallons),	1,538.29	-	284.80	1,823.09
Average dynamic head (feet),	132.94	-	124.05	131.55
Cost per million gallons raised to reservoir,	-	-	-	$17.2827
Cost per million foot gallons,	-	-	-	.1314

Chestnut Hill Pumping Station No. 2.

	Engines Nos. 5, 6 and 7.	Engine No. 12.	Totals.
Daily pumping capacity (gallons),	105,000,000	40,000,000	145,000,000
Coal consumed for year (pounds),	-	-	17,493,533
Cost of pumping, figured on pumping station expenses,	-	-	$99,512.92
Total pumpage for year, corrected for slip (million gallons),	13,351.75	13,872.21	27,223.96
Average dynamic head (feet),	36.26	122.44	80.17
Cost per million gallons raised to reservoir,	-	-	$3.6553
Cost per million foot gallons,	-	-	.0456

Spot Pond Pumping Station.

	Engines Nos. 8 and 9.
Daily pumping capacity (gallons),	30,000,000
Coal consumed for year (pounds),	3,946,797
Cost of pumping, figured on pumping station expenses,	$31,610.04
Total pumpage for year, corrected for slip (million gallons),	3,474.70
Average dynamic head (feet),	131.82
Cost per million gallons raised to reservoir,	$9.0972
Cost per million foot gallons,	.0690

Consumption.

Estimated total population of the eighteen cities and towns supplied wholly or partially during the year 1918,	1,241,460
Total consumption (gallons), meter basis,	47,363,860,000 [1]
Average daily consumption (gallons), meter basis,	129,764,000
Gallons per day to each inhabitant, meter basis,	104.5

Distribution.

	Owned and operated by Metropolitan Water and Sewerage Board.	Total in District supplied by Metropolitan Water Works.
Kinds of pipe used,	–[2]	–[2]
Sizes,	76–4 inch.	76–4 inch.
Extensions, less length abandoned (miles),	1.93	9.41
Length in use (miles),	124.27	1,910.70
Stop-gates added,	3	–
Stop-gates now in use,	536	–
Service pipes added,	–	1,068
Service pipes now in use,	–	183,049
Meters added,	–	1,450
Meters now in use,	–	132,774
Fire hydrants added,	–	162
Fire hydrants now in use,	–	17,705

[1] 67.86 per cent. pumped; 32.14 per cent. by gravity.

[2] Cast-iron, cement-lined wrought-iron, cement-lined steel and kalamine pipe.

Appendix No. 4.

Contracts made and pending during

Contracts relating to the

	1. Number of Contract.	2. WORK.	3. Number of Bids.	Amount of Bid. 4. Next to Lowest.	5. Lowest.	6. Contractor.
1	144	Part of Section 76, Reading Extension, North Metropolitan System, in Wakefield and Reading.	-	-	-	Bruno & Petitti, Boston.

Contracts relating to the

1	138	Section 98, High-level sewer, Wellesley extension, South Metropolitan System in West Roxbury and Dedham.	3	$79,040 00	$54,630 00[1]	Thomas Russo & Co., Boston.
2	139	Part of Section 99, High-level sewer, Wellesley extension, South Metropolitan System in Dedham.	3	93,070 00	92,870 00[1]	Rowe Contracting Co., Boston.
3	143[2]	Section 102, High-level sewer, Wellesley extension, South Metropolitan System in Needham.	3	66,293 40	62,041 75[1]	Bruno & Petitti, Boston.

[1] Contract based upon this bid.

Appendix No. 4.

THE YEAR 1918 — SEWERAGE WORKS.

North Metropolitan System.

7. Date of Contract.	8. Date of Completion of Work.	9. Prices of Principal Items of Contracts made in 1918.	10. Value of Work done Dec. 31, 1918.	
July 29, 1918	-	- - -	$20,979 84	1

South Metropolitan System.

July 13, 1916	-	Work abandoned by the Contractor before any portion was completed. Work provided for is now being completed in accordance with the specifications by Geo. M. Bryne.	$208,334 73	1
June 7, 1918	-	For earth excavation and refilling in trench for 33-in. by 36-in. concrete sewer, $30 per lin. ft.; for earth or rock excavation or both and refilling in tunnel for 33-in. by 36-in. concrete sewer, $38 per lin. ft.; for Portland cement brick masonry in manholes, shafts and special structures, $25 per cu. yd.; for Portland cement concrete masonry in trench and special structures, $23 per cu. yd.; for Portland cement concrete masonry in tunnel, $24 per cu. yd.; for rock excavation in trench, $8 per cu. yd.	19,380 00	2
Oct. 2, 1916	May 1, 1918	- - -	67,953 81	3

[1] Contract completed.

CONTRACTS MADE AND PENDING DURING THE YEAR 1918 — SEWERAGE WORKS — *Concluded.*

Summary of Contracts.

	Value of Work done Dec. 31, 1918.
North Metropolitan System, 1 contract,	$20,979 84
South Metropolitan System, 3 contracts,	295,668 54
Total of 4 contracts made and pending during the year 1918,	$316,648 38

Appendix No. 5.

FINANCIAL STATEMENT PRESENTED TO THE GENERAL COURT ON JANUARY 15, 1919.

The Metropolitan Water and Sewerage Board respectfully presents the following abstract of the account of its receipts, expenditures, disbursements, assets and liabilities for the year ending November 30, 1918, together with recommendations for legislation which it deems desirable, in accordance with the provisions of chapter 235 of the Acts of the year 1906.

Metropolitan Water Works.

Construction.

The loans authorized for expenditures under the Metropolitan Water acts, the receipts which are added to the loan fund, the expenditures for the construction and acquisition of works, and the balance available on December 1, 1918, have been as follows: —

Loans authorized under Metropolitan Water acts, including appropriation under Gen. St. 1918, c. 177, to provide an additional water supply for the towns of Watertown and Belmont,		$42,913,000 00
Receipts from town of Swampscott for admission to Metropolitan Water District, paid into Loan Fund (St. 1909, c. 320),		90,000 00
Receipts from the sales of property which are placed to the credit of the Metropolitan Water Loan Fund: —		
For the year ending November 30, 1918, .	$3,495 78	
For the period prior to December 1, 1917, .	253,647 64	
		257,143 42
		$43,260,143 42
Amount approved for payment by the Board out of the Metropolitan Water Loan Fund: —		
For the year ending November 30, 1918, .	$172,902 31	
For the period prior to December 1, 1917,	42,980,841 25	
		43,153,743 56
Balance December 1, 1918, ...		$106,399 86

The amount of the Metropolitan Water Loan bonds issued at the end of the fiscal year was $42,752,000, no additional bonds having been issued during the year. Of the total amount issued, $41,398,000 were sinking fund bonds, and the remainder, amounting to $1,354,000, were issued as serial bonds.

At the end of the year the amount of outstanding bonds was $42,611,000, as bonds issued on the serial payment plan to the amount of $141,000 had been paid. During the fiscal year $37,000 in serial bonds have been paid.

The Metropolitan Water Loan Sinking Fund amounted on December 1, 1918, to $14,870,834.84, an increase during the year of $834,555.96.

Maintenance.

Amount appropriated for the maintenance and operation of works for the year ending November 30, 1918,	$601,500 00	
Special appropriation for protection of water supply in aqueducts (1911) remaining,	9,930 60	
Special appropriations for protection and improvement of the water supply (1912, 1913 and 1916) remaining,	10,304 36	
Receipts credited to this fund for the year ending November 30, 1918,	3,430 09	
		$625,165 05
Amount approved by Board for maintenance and operation of works during the year ending November 30, 1918,	$588,784 60	
Deduct amount paid from appropriation for year 1917,	28,858 41	
		559,926 19
Balance December 1, 1918,		$65,238 86

This balance includes the sum of $9,930.60, the amount remaining unexpended of the special appropriation for the protection of the water supply in aqueducts, and the sums of $2,713.93, the amount remaining unexpended of the special appropriation in 1912, $39.45 of the special appropriation in 1913, $6,160.54 of the special appropriation in 1916 and $20,000 of the appropriation in 1918 for the protection and improvement of the water supply.

The Board has also received during the year ending November 30, 1918, $92,271.66 from rentals, the sale of land, land products and power and from other proceeds from the operations of the Board,

which, according to section 18 of the Metropolitan Water Act, are applied by the Treasurer of the Commonwealth to the payment of interest on the Metropolitan Water Loan, to sinking fund requirements, and expenses of maintenance and operation of works, in reduction of the amount to be assessed upon the Metropolitan Water District for the year.

Sums received from sales of water to municipalities not belonging to the District and to water companies, and from municipalities for admission to the District, have been applied as follows: —

For the period prior to December 1, 1906, distributed to the cities and towns of the District, as provided by section 3 of the Metropolitan Water Act,	$219,865 65
For the period beginning December 1, 1906, and prior to December 1, 1917, applied to the Metropolitan Water Loan Sinking Fund, as provided by chapter 238 of the Acts of 1907,	76,800 42
For the year beginning December 1, 1917, and ending November 30, 1918, applied to the Metropolitan Water Loan Sinking Fund, as provided by said last-named act,	11,838 14
	$308,504 21

Metropolitan Sewerage Works.

Construction.

The loans authorized under the various acts of the Legislature for the construction of the Metropolitan Sewerage Works, the receipts which are added to the proceeds of the loans, and the expenditures for construction, are given below, as follows: —

North Metropolitan System.

Loans authorized for expenditures for construction under the various acts, including those for the Revere, Belmont and Malden extensions, North System enlargements and extensions, New Mystic Sewer, Deer Island outfall extension, lowering sewer siphon under Malden River, balance of appropriation under chapter 76, Resolves of 1915, and for the Reading extension,	$7,512,365 73
Receipts from sales of real estate and from miscellaneous sources, which are placed to the credit of the North Metropolitan System: —	
For the year ending November 30, 1918,	244 73
For the period prior to December 1, 1917,	85,776 46
Amount carried forward,	$7,598,386 92

Amount brought forward, ...	$7,598,386 92	
Amount approved for payment by the Board [1] out of the Metropolitan Sewerage Loan Fund, North System: —		
For the year ending November 30, 1918, .		$39,887 58
For the period prior to December 1, 1917, .		7,284,364 36
	$7,598,386 92	$7,324,251 94
Balance December 1, 1918, ...		$274,134 98

South Metropolitan System.

Loans authorized for expenditures for construction under the various acts, applied to the construction of the Charles River valley sewer, Neponset valley sewer, High-level sewer and extensions (including Wellesley Branch), and an additional appropriation authorized by chapter 285, General Acts of 1917, and for additional Ward Street station pumping plant, .	$9,587,046 27	
Receipts for pumping, sales of real estate and from miscellaneous sources, which are placed to the credit of the South Metropolitan System: —		
For the year ending November 30, 1918, .	31 10	
For the period prior to December 1, 1917, .	19,383 93	
Amount approved by Board for payment as follows: —		
On account of the Charles River valley sewer, ...		$800,046 27
On account of the Neponset valley sewer,		911,531 46
On account of the High-level sewer and extensions: —		
For the year ending November 30, 1918,		125,402 88
For the period prior to December 1, 1917,		7,633,190 03
	$9,606,461 30	$9,470,170 64
Balance December 1, 1918, ...		$136,290 66

The amount of the Metropolitan Sewerage Loan bonds issued at the end of the fiscal year was $17,086,412, bonds to the amount of $325,000 having been issued during the year. Of the total amount

[1] The word "Board" refers to the Metropolitan Sewerage Commission and its successor, the Metropolitan Water and Sewerage Board.

issued, $15,440,912 were sinking fund bonds, and the remainder, amounting to $1,645,500, were serial bonds.

At the end of the year the amount of the outstanding bonds was $16,617,912, as bonds issued on the serial payment plan to the amount of $47,500 had been paid during the year, $143,500 having been paid to December 1, 1918.

Of the total amount outstanding at the end of the year, $7,387,000 were issued for the North Metropolitan System and $9,555,912 for the South Metropolitan System. The Metropolitan Sewerage Loan Sinking Fund amounted on December 1, 1918, to $4,270,205.50, of which $2,690,491.90 were on account of the North Metropolitan System and $1,579,713.60 were on account of the South Metropolitan System, an increase during the year of $344,412.75.

The net debt on December 1, 1918, was $12,672,706.50, a decrease of $66,912.75.

Included in the above figures for the North Metropolitan System are $925,000 in serial bonds, of which $101,500 have been paid, and $720,000 for the South Metropolitan System, of which $42,000 have been paid.

Maintenance.

North Metropolitan System.

Appropriated for the year ending November 30, 1918,	$235,700 00
Receipts from pumping and from other sources, which are returned to the appropriation: —	
For the year ending November 30, 1918,	682 43
	$236,382 43
Amount approved for payment by the Board: —	
For the year ending November 30, 1918,	230,365 79
Balance December 1, 1918,	$6,016 64

South Metropolitan System.

Appropriated for the year ending November 30, 1918,	$145,860 00
Receipts from sales of property, reimbursement and for pumping, which are returned to the appropriation: —	
For the year ending November 30, 1918,	10,746 63
	$156,606 63
Amount approved for payment by the Board: —	
For the year ending November 30, 1918,	149,253 09
Balance December 1, 1918,	$7,353 54

APPENDIX No. 6.

LEGISLATION OF THE YEAR 1918 AFFECTING THE METROPOLITAN WATER AND SEWERAGE BOARD.

General Acts, 1918.

CHAPTER 3.

AN ACT RELATIVE TO THE INTEREST ON BONDS ISSUED FOR THE CONSTRUCTION OF A POWER TRANSMISSION LINE BETWEEN THE WACHUSETT DAM AND THE SUDBURY DAM.

Be it enacted, etc., as follows:

1917, 287 (G), § 1, amended.

SECTION 1. Section one of chapter two hundred and eighty-seven of the General Acts of the year nineteen hundred and seventeen is hereby amended by striking out the words "Act of 1917", in the tenth and eleventh lines, and adding at the end thereof the words: — except that the rate of interest to be paid thereon shall be such as the treasurer and receiver general, with the approval of the governor and council, may determine, — so as to read as follows: —

Rate of interest on bonds for power transmission line between Wachusett and Sudbury dams.

Section 1. To enable the metropolitan water and sewerage board to construct a line for the transmission of electricity between the power station at the Wachusett dam in Clinton and the power station at the Sudbury dam in Southborough, under authority of chapter one hundred and seventy-two of the General Acts of the year nineteen hundred and sixteen, the treasurer and receiver general shall issue from time to time, upon the request of said board, bonds in the name and behalf of the commonwealth, designated on the face thereof, Metropolitan Water Loan, to an amount not exceeding twelve thousand dollars, to be taken from the unexpended balance of forty-six thousand dollars authorized by chapter six hundred and ninety-four of the acts of the year nineteen hundred and twelve; and the provisions of chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five, and

of acts in amendment thereof and in addition thereto, shall, so far as they may be applicable, apply to the indebtedness and proceedings authorized by this act, except that the rate of interest to be paid thereon shall be such as the treasurer and receiver general, with the approval of the governor and council, may determine.

SECTION 2. This act shall take effect upon its passage. [*Approved February 7, 1918.*

CHAPTER 5.

AN ACT RELATIVE TO THE INTEREST ON BONDS ISSUED FOR THE CONSTRUCTION OF A WATER MAIN IN THE EAST BOSTON DISTRICT OF THE CITY OF BOSTON.

Be it enacted, etc., as follows:

SECTION 1. Section two of chapter three hundred and twenty-two of the General Acts of the year nineteen hundred and seventeen is hereby amended by striking out the words "Act of 1917", in the sixth line, and adding at the end thereof the words: — except that the rate of interest to be paid thereon shall be such as the treasurer and receiver general, with the approval of the governor and council, may determine, — so as to read as follows: — *Section 2.* To meet the expenses incurred under the provisions of this act, the treasurer and receiver general shall issue from time to time, upon the request of said board, bonds in the name and behalf of the commonwealth and under its seal, designated on the face thereof Metropolitan Water Loan, to an amount not exceeding thirty thousand dollars, to be taken from the unexpended balance of the amount authorized by chapter six hundred and ninety-four of the acts of the year nineteen hundred and twelve, and the provisions of chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five, and acts in amendment thereof and in addition thereto, shall, so far as applicable, apply to the indebtedness and proceedings authorized by this act, except that the rate of interest to be paid thereon shall be such as the treasurer and receiver general, with the approval of the governor and council, may determine.

1917, 322 (G), § 2, amended.

Rate of interest on bonds for water main to East Boston.

SECTION 2. This act shall take effect upon its passage. [*Approved February 7, 1918.*

Chapter 6.

An Act relative to the interest on bonds issued for completing the extension of the south metropolitan sewer to the town of Wellesley.

Be it enacted, etc., as follows:

1917, 285 (G), § 1, amended.

Section 1. Section one of chapter two hundred and eighty-five of the General Acts of the year nineteen hundred and seventeen is hereby amended by adding at the end thereof the words: — except that the rate of interest to be paid thereon shall be such as the treasurer and receiver general, with the approval of the governor and council, may determine, — so as to read as follows: — *Section 1.* The treasurer and receiver general, in order to provide for the completion of the extension of the high-level sewer authorized by chapter three hundred and forty-three of the acts of the year nineteen hundred and fourteen, shall, with the approval of the governor and council, issue from time to time scrip or certificates of indebtedness in the name and behalf of the commonwealth and under its seal, to an amount not exceeding three hundred and twenty-five thousand dollars, in addition to the amount authorized by said chapter; and the provisions of said chapter and of chapter four hundred and twenty-four of the acts of the year eighteen hundred and ninety-nine, and of all acts in amendment thereof and in addition thereto shall, so far as they may be applicable, apply to the indebtedness and proceedings authorized by this act, except that the rate of interest to be paid thereon shall be such as the treasurer and receiver general, with the approval of the governor and council, may determine.

Rate of interest on bonds for completing sewer extension to town of Wellesley.

Section 2. This act shall take effect upon its passage. [*Approved February 7, 1918.*

Chapter 157.

An Act to provide for the completion of certain authorized improvements in the metropolitan water works.

Be it enacted, etc., as follows:

Completion of certain authorized improvements in the metropolitan water works.

The treasurer and receiver general, in order to provide for the increased cost of constructing a line for the transmission of electricity between the power station at the

Wachusett dam in Clinton and the power station at the Sudbury dam in Southborough, to relocate and connect meters for the measuring of water supplied through the low service to the metropolitan water district, to construct a 12-inch pipe line in Poplar street, West Roxbury, and under the Neponset river, and to install a new pumping engine at the Arlington pumping station, all of which improvements were authorized by chapter one hundred and seventy-two of the General Acts of nineteen hundred and sixteen, shall issue from time to time, upon the request of the metropolitan water and sewerage board, bonds in the name and behalf of the commonwealth and under its seal, to an amount not exceeding four thousand dollars, said sum being the amount of the unexpended balance of six hundred thousand dollars authorized by chapter six hundred and ninety-four of the acts of nineteen hundred and twelve. [*Approved April 20, 1918.*

CHAPTER 177.

AN ACT TO AUTHORIZE THE METROPOLITAN WATER AND SEWERAGE BOARD TO PROVIDE AN ADDITIONAL WATER SUPPLY FOR THE TOWNS OF WATERTOWN AND BELMONT.

Be it enacted, etc., as follows:

Additional water supply for Watertown and Belmont.

SECTION 1. The metropolitan water and sewerage board is hereby authorized to provide an additional water supply from the southern high service of the metropolitan water system for the towns of Watertown and Belmont, and to construct such mains, pipe lines, conduits and works as may be necessary therefor.

Issue of bonds to meet expenses, etc.

SECTION 2. To meet expenses incurred hereunder, the treasurer and receiver general shall, from time to time, issue, upon the request of said board, bonds in the name and behalf of the commonwealth to an amount not exceeding one hundred and fifteen thousand dollars in addition to the sum of forty-two million seven hundred and ninety-eight thousand dollars authorized by chapter four hundred and eighty-eight of the acts of eighteen hundred and ninety-five and acts in amendment thereof and in addition thereto, and the provisions of said chapter and acts shall apply to the loan hereby authorized.

SECTION 3. This act shall take effect upon its passage. [*Approved April 26, 1918.*

Special Act, 1918.

CHAPTER 45.

AN ACT RELATIVE TO THE INSTALLATION OF WATER METERS IN THE CITY OF BOSTON.

Be it enacted, etc., as follows:

City of Boston, installation of water meters deferred.

SECTION 1. The provisions of section one of chapter five hundred and twenty-four of the acts of nineteen hundred and seven shall not apply to the city of Boston for one year after the taking effect of this act, in so far as the same require the equipment with water meters of five per cent of water services in said city which were unmetered on the thirty-first day of December, nineteen hundred and seven.

Time of taking effect.

SECTION 2. This act shall take effect upon the tenth day of April, nineteen hundred and eighteen. [*Approved February 25, 1918.*

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